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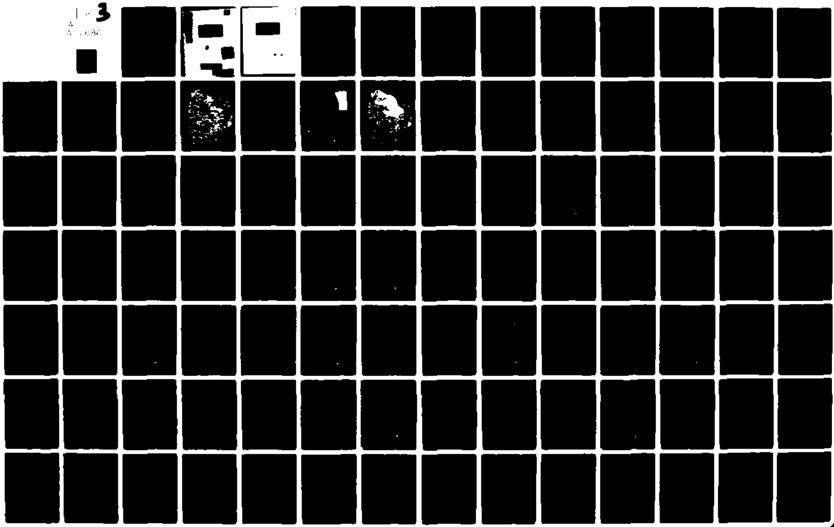

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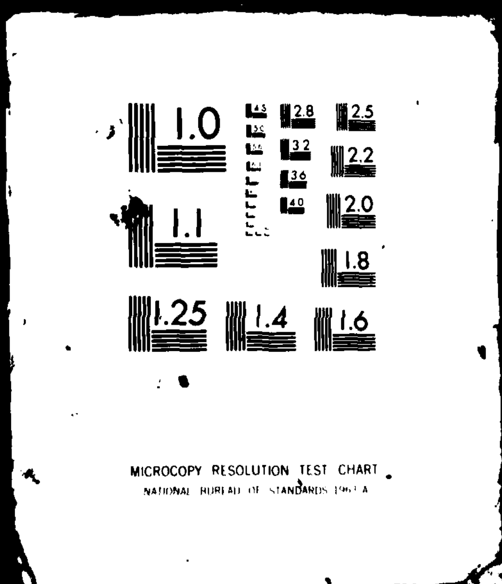

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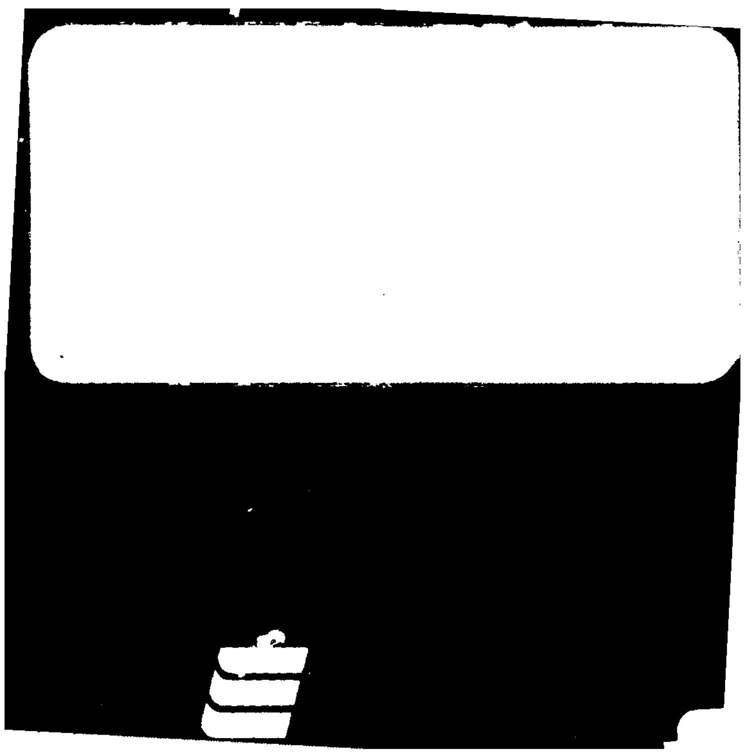

E-TR-47-PI

MX SITING INVESTIGATION
GEOTECHNICAL EVALUATION

DETAILED AGGREGATE RESOURCES STUDY

PINE VALLEY, UTAH

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office
Norton Air Force Base, California 92409

Prepared by:

Ertec Western, Inc.
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12 June 1981

Ertec

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: E-TR-47-PI
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): Detailed Aggregate Resources Study Pine Valley, Utah
5. TYPE OF REPORT & PERIOD COVERED: Final
6. PERFORMING ORG. REPORT NUMBER: E-TR-47-PI
7. AUTHOR(s): Ertec, Western, Inc.
8. CONTRACT OR GRANT NUMBER(s): F04704-80-C-0006
9. PERFORMING ORGANIZATION NAME AND ADDRESS: [illegible]
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 64312 F
11. CONTROLLING OFFICE NAME AND ADDRESS: [illegible]
12. REPORT DATE: 12 Jun 81
13. NUMBER OF PAGES: 89
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):
15. SECURITY CLASS. (of this report):

15a. DECLASSIFICATION DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Distribution Unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Geology ~~Setting~~, ~~Road Base~~ Aggregates ~~[illegible]~~, ~~Concrete Aggregates Eval~~, grain size, trench logs, Caliche, soil, petrography

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Detailed aggregate resources study, Pine Valley, Utah. Report contains analysis, evaluation and quantity of aggregate resources found in Pine Valley. Classes RBIa, RBIb, RBII for Road-base and Classes CA1, CA2, C3, CC1 and CC2 for concrete.

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FOREWORD

This report is one of a series prepared for the Department of the Air Force, Ballistic Missile Office (BMO), in compliance with Contract No. F04704-80-C-0006, CDRL Item No. 004A2. These reports present the results of Detailed Aggregate Resources Studies within and adjacent to selected areas in Nevada and Utah that are under consideration for siting the MX missile system.

This volume contains the results of the aggregate resources evaluation for Pine Valley. Results of this report are presented as text, appendices, and three drawings. This report has been prepared and submitted on the assumption that the reader is familiar with previous aggregate resources reports.

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EXECUTIVE SUMMARY

This report contains the Detailed Aggregate Resources Study (DARS) evaluation for Pine Valley, Utah. It is the fifth in a series of reports that contain detailed aggregate information on the location and quality of basin-fill and rock sources of road-base and concrete aggregates. Field reconnaissance, laboratory testing, and existing data from other Ertec Western, Inc. (formerly Fugro National, Inc.) investigations and the Utah State Department of Highways provide the basis for the findings presented in this report.

ROAD-BASE AGGREGATES

Potential road-base aggregate sources were classified as follows:

Class RBIa - Basin-fill or rock sources containing materials suitable for use as road-base aggregates; based on acceptable laboratory aggregate test results.

Class RBIb - Basin-fill sources containing materials suitable for use as road-base aggregates; based on correlation with Class RBIa source areas.

Class RBII - Potential basin-fill sources of materials suitable for use as road-base aggregates; based on photogeologic interpretations, field observations, and limited or inconclusive sieve analysis and/or abrasion data.

Assignment of an aggregate source to one of the above three classes was determined from laboratory test results (gradation, abrasion and, to a lesser extent, soundness) and geomorphological and compositional correlations.

Results of this evaluation are presented on a 1:62,500 scale aggregate resources map (Drawing 2) and are summarized as follows:

Class RBIa Sources: Twelve basin-fill sources consisting of good- to high-quality aggregates acceptable for use as road-base construction materials have been located in the valley. The 11 most extensive deposits are alluvial fans (Aaf). Most of the sources are located on the east side of the valley.

Five crushed-rock sources which yielded good- to high-quality aggregates acceptable for use as road-base construction materials have been delineated within the study area. These sources include outcrops of quartzite (Qtz), limestone (Ls), and undifferentiated carbonate rocks (Cau).

Class RBIb Sources: Eleven basin-fill deposits within the study area are defined as potential sources of good- to high-quality, road-base aggregates. Geomorphological and compositional similarities were used to correlate these units to tested RBIa deposits. Deposits are all alluvial fans generally confined to the east side of the valley.

Class RBII Sources: Several potential basin-fill aggregate sources are located throughout the study area. All of these sources are alluvial fans that have been classified on the basis of limited field and laboratory data.

CONCRETE AGGREGATES

A classification system consisting of five classes was developed for the concrete aggregates evaluation to present potential basin-fill and crushed-rock sources. Although most rock sources will supply coarse concrete aggregates, their delineation was not an objective of this study. Assignment of an aggregate source to one of the five classes was determined from laboratory test results (trial concrete mixes and gradation, abrasion, and

soundness of aggregates) and geomorphological and compositional correlations. The emphasis of this study was the evaluation of the concrete-making properties (especially 28-day compressive strengths) of potential aggregates when used in trial concrete mixes.

Class CA1	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths equal to or greater than 6500 psi.
Class CA2	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths less than 6500 psi.
Class CB	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on acceptable laboratory aggregate test results.
Class CC1	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CA1 and CA2 source areas.
Class CC2	Basin-fill sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CB source areas.

The following three trial mixes were used to obtain a range of compressive strength values; however, only Mix 3 results were used to classify sources. In all three trial mixes, fly ash, as a pozzolan, replaced 20 percent of the cement by weight.

- Mix 1 - 7.5 sacks of cement per cubic yard of concrete and 1.5-inches maximum aggregate size;
- Mix 2 - 8.5 sacks of cement per cubic yard of concrete and 1.5-inches maximum aggregate size; and
- Mix 3 - 8.5 sacks of cement per cubic yard of concrete, 0.75-inch maximum aggregate size, and a superplasticizer.

Results of this evaluation are presented on a 1:62,500 scale aggregate resources map (Drawing 3) and summarized as follows:

Class CA1 and Class CA2 Sources:	One basin-fill deposit in the area contained aggregates that, when used in Mix 3, produced 28-day compressive strengths greater than 6500 psi. This source is an alluvial fan (Aaf) located on the east side of the valley.
	Crushed-rock aggregates from two rock sources in the study area produced 28-day compressive strengths in excess of 6500 psi. These rock sources consist of undifferentiated carbonate rocks (Cau) and quartzite (Qtz). Fine aggregates used in conjunction with crushed rock in these concrete mixes passed magnesium sulfate soundness tests.
	One basin-fill deposit in the area contained aggregates that, when used in Mix 3, produced 28-day compressive strengths less than 6500 psi. This source is an alluvial fan located on the east side of the valley.
	Sufficient quantities of fair to satisfactory quality fine aggregates are available in most basin-fill deposits. High-quality, fine aggregate sources are of limited extent within the study area.
Class CB Sources:	Eleven basin-fill deposits consisting of good- to high-quality aggregates, potentially acceptable for use as sources of concrete construction materials, were delineated in the valley. All but one of these deposits are alluvial fans.
Class CC1 Sources:	Two alluvial fans in the study area are classified as potential sources of concrete aggregates. They are correlated to Class CA1 and CA2 sources based on geomorphological and compositional similarities.
Class CC2 Sources:	Several basin-fill units located throughout the valley are potential sources of aggregates suitable for use in concrete. They are correlated to Class CB units on the basis of geomorphological and compositional similarities.

CONCLUSIONS

Sufficient quantities of coarse and fine aggregates suitable for use as road-base and/or concrete-construction material are available in Pine Valley. Laboratory test results indicate that the quality of the coarse aggregates ranges from good to excellent and the quality of the fine aggregates ranges from fair to satisfactory. Most of the aggregate sources are confined to the eastern and southern portions of the valley.

RECOMMENDATIONS

Additional aggregate field investigations and laboratory testing will be required to further refine the physical and chemical characteristics of road-base and concrete aggregate sources as borrow areas prior to the initiation of construction.

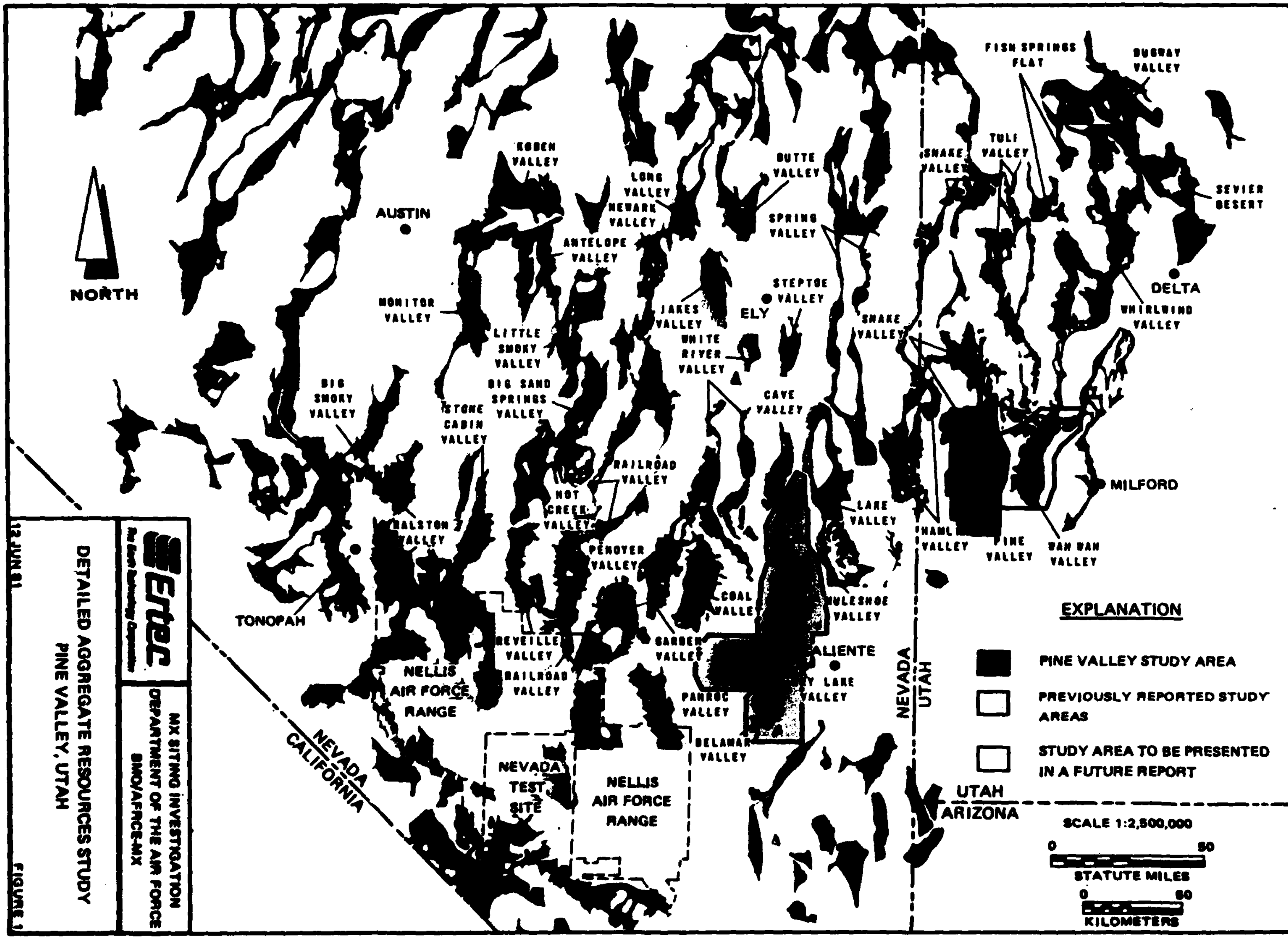
1.0 INTRODUCTION

1.1 STUDY AREA

This report presents the results of the Detailed Aggregate Resources Study (DARS) for Pine Valley (Figure 1). Pine Valley is located in southern Millard and northern Beaver counties, Utah. It is bounded on the west by the Indian Peak and The Needles ranges and by the Desert Range Experimental Station and on the east by the Wah Wah Mountains. The valley is topographically open to Snake Valley to the north. Highway 21 is the only paved road in the vicinity. A network of graded roads and four-wheel-drive trails provide access to most parts of the study area. Pine Valley is mainly undeveloped desert rangeland administered by the Bureau of Land Management (BLM). The Desert Range Experimental Station is managed by the State of Utah. Several active mining operations are located in the Wah Wah Mountains. Milford, Utah, is located approximately 36 miles (58 km) east of Pine Valley on Highway 21.

1.2 BACKGROUND

Aggregate resources studies for the MX program were introduced in 1977 with the investigation of Department of Defense (DoD) and BLM lands in California, Nevada, Arizona, New Mexico, and Texas (FN-TR-20D). Refinement of the MX siting area added portions of Utah and Nevada that were not evaluated in this initial Aggregate Resources Evaluation Investigation (AREI). This additional area, defined as the Utah-Nevada aggregate resources study area, was examined in the fall of 1979 and a



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DETAILED AGGREGATE RESOURCES STUDY
PINE VALLEY, UTAH

12 JUN 81

FIGURE 1

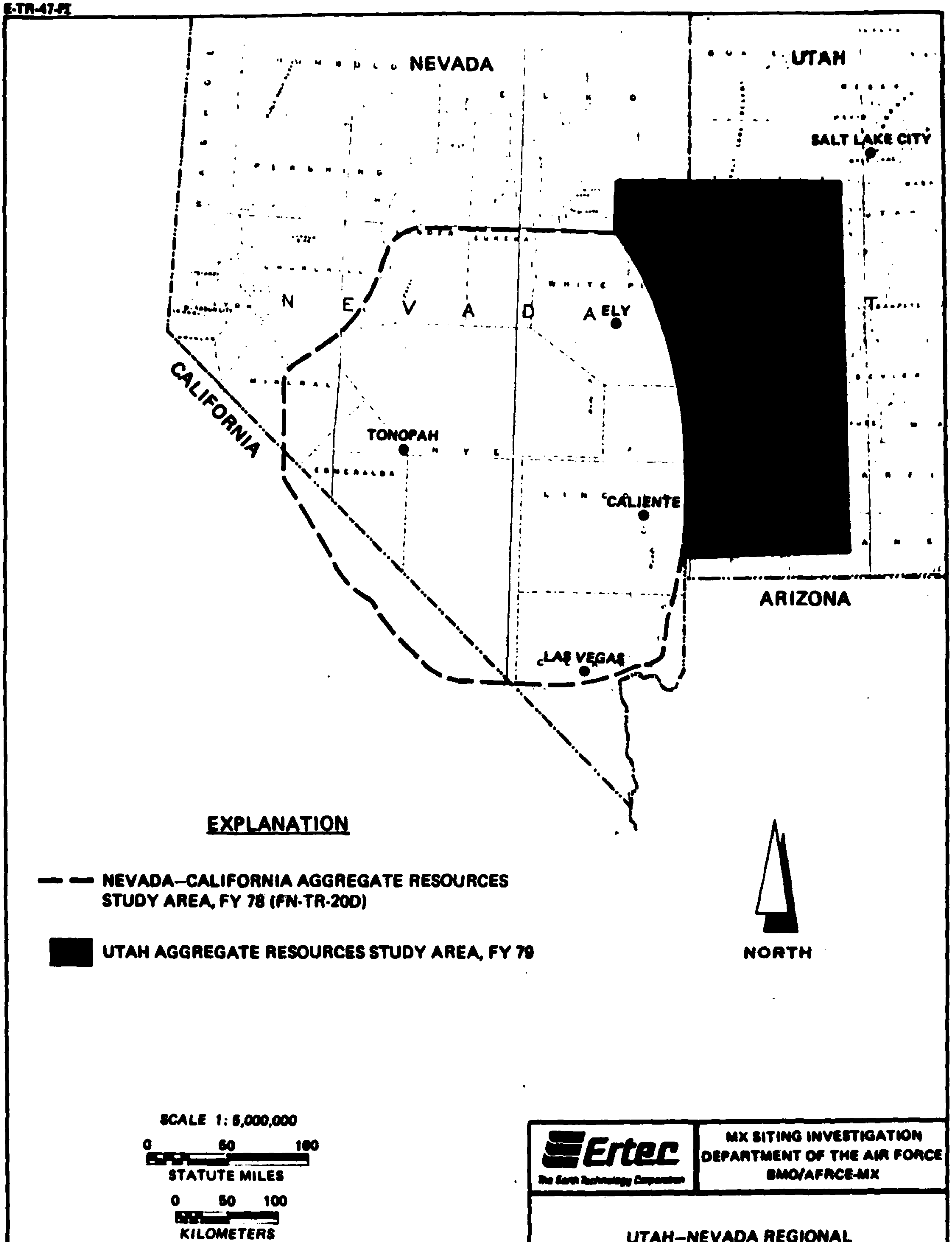
second regional aggregate resources report (FN-TR-34) was submitted on 3 March 1980 (Figure 2).

Both regional aggregate investigations consisted of the compilation and evaluation of existing data with limited field reconnaissance, sample collection, and laboratory aggregate testing. Only general information on the location, quality, and quantity of aggregates was provided.

Subsequent to the regional studies, Valley-Specific Aggregate Resources Studies (VSARS) were started in FY 79. The primary objective of these continuing studies is to provide additional information on potential aggregate sources in specified valleys and in the areas immediately surrounding them. Existing exposures of potential basin-fill and rock aggregate sources are sampled and subjected to a suite of laboratory tests. Results of these tests are used to classify coarse and fine basin-fill and crushed-rock aggregates for suitability as concrete and road-base construction materials.

The aggregate sources presented in the VSARS are to be used as a guide for preliminary construction planning and the selection of areas for more detailed-aggregate evaluations. To date, field investigations have been completed for 16 valley areas with final reports submitted for 11 valley areas (Figure 3). Field investigations for remaining valleys in the designated deployment area are planned in FY 81 and FY 82.

The DARS were initiated in FY 81 to further analyze and refine potential sources of coarse and fine basin-fill and crushed-rock



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UTAH–NEVADA REGIONAL AGGREGATE STUDIES

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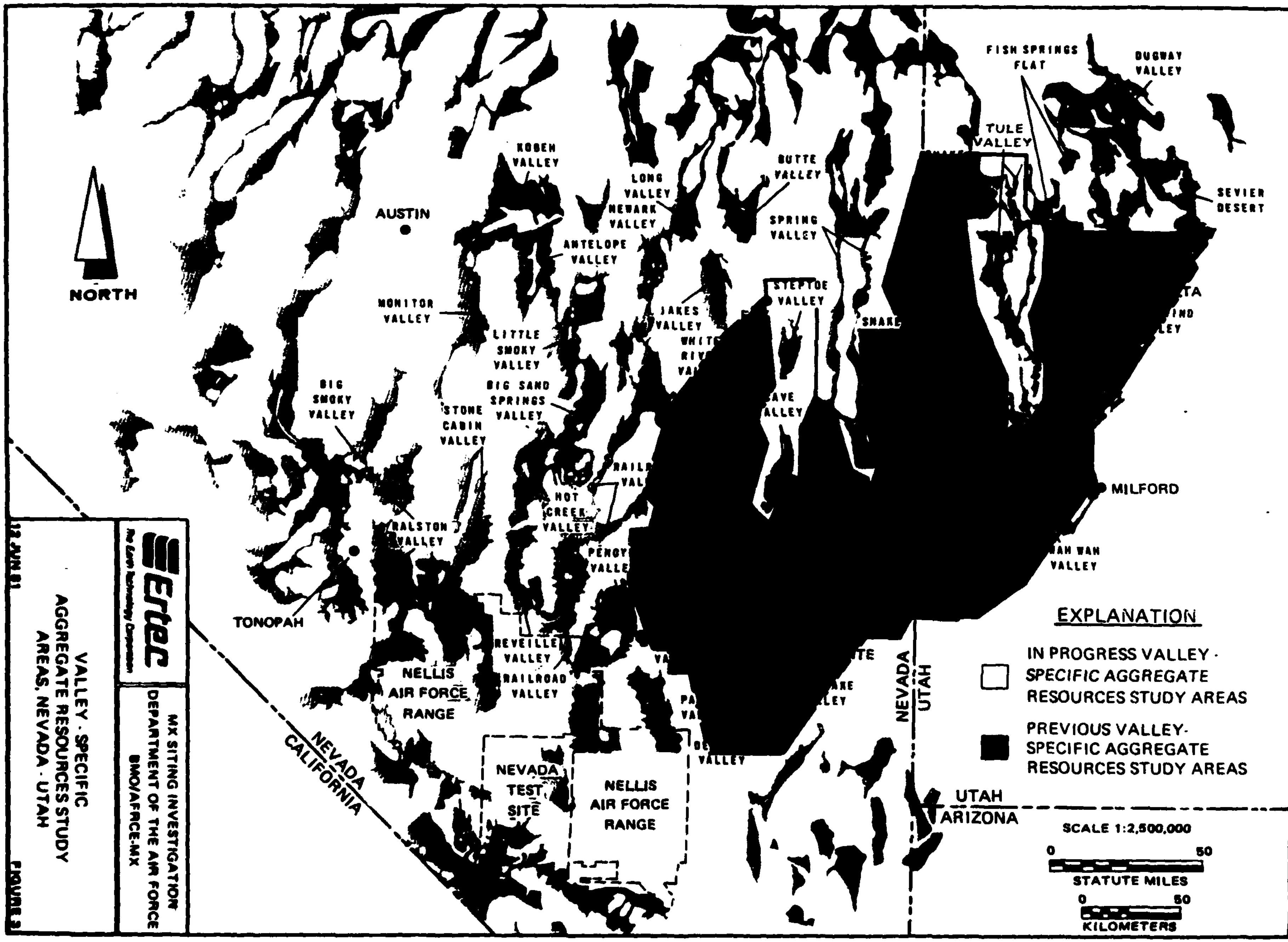
FIGURE 2



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VALLEY - SPECIFIC AGGREGATE RESOURCES STUDY AREAS, NEVADA - UTAH

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FIGURE 3

aggregates identified during the VSARS. These studies consist of both road-base (Section 3.0) and concrete (Section 4.0) aggregate evaluations. The major consideration was to further evaluate basin-fill deposits as potential sources of road-base and concrete aggregates. Limited new data were developed on crushed-rock sources.

1.3 OBJECTIVES

The objectives of the Detailed Aggregate Resources Study are as follows:

Road-Base Aggregates Evaluation

- o Refine potential basin-fill and rock sources (initially identified in VSARS) for road-base aggregates; and
- o Provide additional laboratory test data on the general quality of basin-fill aggregates for use as road-base material.

Concrete Aggregates Evaluation

- o Refine the areal extent of the most acceptable VSARS basin-fill and rock concrete aggregate sources; and
- o Provide additional laboratory testing information on the quality and the concrete-making properties of potential coarse and fine, basin-fill and crushed-rock aggregates.

1.4 SCOPE

The scope of the two evaluations required office and field studies and included the following:

a. Compilation and analysis of appropriate existing data on the quality and quantity of potential road-base and concrete aggregates. Major sources of data were other Ertec investigations for the siting of the MX system and the Utah State Department of Highways.

b. Initial and final basin-fill deposit differentiation based on geomorphology, grain size, lithology, and aerial-photograph and topographic-map interpretation. Initial and

final rock unit divisions based on evaluations of aerial photographs and published geologic maps.

c. Staking and permitting on selected BLM lands. Appropriate basin-fill trench locations for samples of road-base and concrete aggregates were determined from items a and b and a brief field reconnaissance.

d. Backhoe excavation of staked and permitted basin-fill locations, sampling when gravel percentage exceeded 30 percent, or when suitable fine aggregates for concrete mixes were present. Selection and sampling of acceptable crushed-rock sources of coarse aggregates for concrete mixes.

e. Valley-wide field reconnaissance utilizing aerial photographs and petrographic and grain-size analyses to determine lateral extent and acceptability of basin-fill deposits.

f. Laboratory tests to supplement available existing data for the determination of the suitability of specific basin-fill and rock units as sources of road-base or concrete aggregates. Trial (check) concrete mixes were made to evaluate the basic concrete-making properties of selected concrete aggregate sources as well as engineering properties of hardened concrete.

g. Development and application of road-base and concrete materials classification systems that textually and graphically depict the locations of the most suitable aggregate sources in the study area. The depiction and discussion of areas that are unsuitable or have a low probability for use were not done.

2.0 GEOLOGIC SETTING

2.1 PHYSIOGRAPHY

Pine Valley lies within the Basin and Range Physiographic Province and exhibits characteristic north-south trending, block-faulted mountain ranges with an intervening alluvial basin. Elevations range from about 6800 feet (2073 m) in the east-central part of the valley to 5075 feet (1547 m) on the playa in the northern part of the valley.

Mountain ranges flanking the basin are the Wah Wah Mountains to the east, the Indian Peak Range to the south and southwest, and The Needles Range, Tunnel Spring Mountains, and Middle Mountain to the west. Pine Valley is contiguous to Snake Valley to the north through a narrow pass between the Tunnel Spring Mountains and Middle Mountain. Topographic relief between mountain ridges and the basin floor ranges from about 3120 feet (951 m) to 2140 feet (652 m) in the Wah Wah Mountains, about 1265 feet (386 m) in The Needles Range, and about 1100 feet (335 m) in the Indian Peak Range. Pine Valley has a closed drainage system to the Pine Valley Hardpan except for the extreme southern part of the valley which drains south to the Escalante Desert area.

2.2 LOCATION AND DESCRIPTION OF GEOLOGIC UNITS

Paleozoic and Cenozoic rocks are found in bedrock outliers within the valley and in the mountains in and adjacent to the study area. The Paleozoic rocks consist predominantly of limestone, dolomite, and quartzite with interbedded sandstone and shale. These units crop out along the margins of the entire study area.

Unconformably overlying the Paleozoic rocks are Cenozoic rocks consisting predominantly of undifferentiated Tertiary volcanic and intravolcanic sedimentary rocks. Unconsolidated Cenozoic deposits lie unconformably above all older units and consist primarily of alluvial, lacustrine, and stream-channel and terrace deposits.

Specific Paleozoic and Cenozoic geologic units have been grouped into three rock and three basin-fill categories for use in discussing potential aggregate sources. The grouping of the units was based on similarities in physical and chemical characteristics and map-scale limitations. The resulting categories simplify discussion and presentation without altering the conclusions of the study.

Additional geologic information is presented in previous Ertec reports (FN-TR-37-g; and FN-TR-27-PI-I and II).

2.2.1 Rock Units

Geologic rock units that are potential sources of crushed-rock aggregates are grouped into the following three categories: quartzite (Qtz), limestone (Ls), and carbonate rocks undifferentiated (Cau). While other rock units may locally supply aggregates, they are not considered major sources and will not be discussed in this report.

2.2.1.1 Quartzite - Qtz

Two quartzite rock units (Qtz) are present in the study area. They are the Cambrian Prospect Mountain Quartzite and the Ordovician Eureka Quartzite.

The Cambrian Prospect Mountain Quartzite crops out in the Wah Wah Mountains and is found as outliers adjacent to the Wah Wah Mountains. This unit consists of thin- to thick-bedded, fine- to medium-grained, pinkish-gray to reddish-brown orthoquartzite with interbedded sandstone, micaceous shale, and conglomerate.

The Ordovician Eureka Quartzite is exposed primarily in the central Needles Range and southern Tunnel Spring Mountains. The Eureka Quartzite consists of thin- to thick-bedded, fine- to medium-grained, light-brown to white orthoquartzite with interbedded sandstone and shale near the base and top of the unit.

2.2.1.2 Limestone - Ls

Units mapped as limestone (Ls) include the Cambrian Marjum Formation and the upper white marker bed of the Weeks Formation. These units are located in the Wah Wah Mountains. They are typically thin- to thick-bedded, fine- to coarse-grained, light- to dark-gray limestone with interbedded chert, sandstone, siltstone, and shale.

2.2.1.3 Carbonate Rocks Undifferentiated - Cau

The single unit mapped as undifferentiated carbonate rocks (Cau) is the Cambrian Wheeler Formation, occurring in the Wah Wah Mountains. The lithology of this unit varies considerably; however, it is typically medium- to thick-bedded, fine- to medium-grained, medium- to dark-gray dolomite, limestone, and locally dolomitic limestone with interbedded clastic rocks and chert.

2.2.2 Basin-fill Units

The basin-fill units within the study area that are potential sources of coarse and fine aggregates are alluvial fan deposits (Aaf), stream-channel and terrace deposits (Aal), and older lacustrine deposits (Aol). The grouping of the units was based on similarities in physical and chemical characteristics and map-scale limitations. All other basin-fill units may locally supply aggregates but are not considered major sources and will not be discussed in this report.

2.2.2.1 Alluvial Fan Deposits - Aaf

Alluvial fans deposits (Aaf) are the most extensive potential sources of basin-fill aggregates within the study area. They occur as a narrow band along most of the eastern and southern sides of the study area and as isolated deposits on the west side of the valley and along the eastern and southern boundaries of the Desert Range Experimental Station. Alluvial fan deposits are typically heterogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay.

Fans derived from quartzite and carbonate rock sources are coarser grained and contain many cobbles and boulders. Fans derived from volcanic rock sources are predominantly fine gravel and sand.

Most alluvial fan deposits have developed soil horizons consisting of silty, clayey sand a few inches to 1 foot (0.3 m) in thickness overlying a zone of carbonate accumulation (caliche). The caliche horizon generally ranges in thickness from 1 to

3 feet (0.3 to 1 m) and exhibits Stage I to III development with Stage II to III being most common (Appendix F).

2.2.2.2 Stream Channel and Terrace Deposits - Aal

Stream-channel and terrace deposits (Aal) in the study area are associated with ephemeral streams within the valley. They range in composition from sandy gravel and gravelly sand near the mountain fronts to sandy silt near the valley axis. The greatest concentration of major stream-channel and terrace deposits is in the southern portion of the study area. Although other deposits were identified during the VSARS as potential aggregate sources, only one was delineated during this investigation. Caliche development within the stream-channel deposits ranges from absent to incipient Stage I.

2.2.2.3 Older Lacustrine Deposits - Aol

Older lacustrine deposits (Aol) in Pine Valley were formed by Pleistocene Lake Wah Wah. The elevation of the highest lake level for Lake Wah Wah is unknown. Shoreline bar deposits north of the Pine Valley Hardpan are evidence that there was a shoreline at approximately 5200 feet (1585 m). Older lacustrine shoreline bar deposits are typically poorly graded, moderately stratified sand. Caliche is present as coatings on the gravel and sand particles.

3.0 ROAD-BASE AGGREGATES EVALUATION

3.1 STUDY APPROACH

The primary objective of the road-base aggregate study was to evaluate the suitability of basin-fill and rock aggregates for use as road base. Two important considerations were applied to basin-fill aggregate sources identified as potentially suitable in VSARS; refinement of source boundaries, and additional laboratory tests to further evaluate physical and chemical characteristics. Sources of crushed-rock aggregates were refined using only existing data, published geologic maps, and limited photogeologic interpretations. Information on potential rock sources for use as road-base aggregates was not specifically collected for this evaluation. Only existing VSARS data and data developed from the concrete aggregates evaluation (Section 4.0) were assessed.

The study approach for the road-base aggregates evaluation required a review of previous Ertec Verification (FN-TR-27-PI-I and II) and aggregate reports (FN-TR-34 and FN-TR-37-g) for Pine Valley. This data base helped define the scope of the road-base materials investigation which included office and field photogeologic and topographic interpretations, field reconnaissance, and collection and laboratory testing of basin-fill samples.

3.1.1 Requirements for Road-Base Aggregates

For the purpose of this report, road-base aggregates are defined using the Nevada Department of Highways (1976) classification of

Type I Class A aggregate base. The requirements for aggregates suitable for such a base are as follows:

Gradation:

Sieve Size	Percent Passing by Weight
1.5 inches	100
1.0 inch	80-100
No. 4	30- 65
No. 16	15- 40
No. 200	2- 12

Fractured Faces .... 35 percent, minimum
Plasticity Index .... 3-15 percent
Liquid Limit .... 35 maximum
Resistance (R value) .... 70 minimum
Percent Wear (500 Rev.) .... 45 percent, maximum

During the road-base aggregate studies, gradation and percent wear were the two primary criteria used to evaluate potential source areas. Magnesium sulfate ($MgSO_4$) soundness tests were performed on selected aggregate samples to gain additional information related to the effects of weathering on aggregates. Soundness losses exceeding 18 percent were considered potentially unacceptable (American Society of Testing and Materials, 1978). The remaining requirements were not evaluated during this study.

3.1.2 Data Acquisition and Analysis

Office studies for the road-base aggregates evaluation required preliminary basin-fill and rock-unit differentiation based on photogeologic interpretations and published topographic and geologic maps. All available data on basin-fill, grain-size gradations were compiled to estimate gravel content for the defined basin-fill units.

The field program involved backhoe excavation of 58 trenches selected during office studies and initial field reconnaissance. Trenches were excavated and sampled in groups of two or three, 0.1 to 0.2 mile (0.2 to 0.3 km) apart, or groups of five, 150 feet (46 m) apart, to characterize individual basin-fill units. Completion depths ranged from 12 to 15 feet (3.7 to 4.6 m) and, where collected, representative samples averaged 100 pounds (45 kg) per trench.

Due to gradation variability in basin-fill deposits, field limits of 30 percent or more gravel and 20 percent or less silt and clay were established as basic aggregate grain-size distribution requirements. Gravel is defined as coarse aggregates which pass the 3.0-inch (75-mm) sieve and are predominantly retained on a No. 4 (4.75-mm) sieve. Aggregates larger than 3.0 inches (cobbles and boulders) were generally present in the materials investigated but were not included in the laboratory samples because of sample-size limitations. Silt and clay particles are defined as material passing through a No. 200 sieve (0.0029-inch [0.075-mm]).

Field studies also included 46 petrographic and grain-size data field stops and valley-wide photogeologic field reconnaissance. These analyses were performed to supplement and confirm office studies and to provide a data base for lithologic and gradation correlations of basin-fill units.

Laboratory testing that included 63 sieve analyses, 15 abrasion tests, and eight $MgSO_4$ soundness tests was performed to broaden

the existing data base during the road-base aggregates evaluation. Confirmation test data (gradation, abrasion, and soundness tests) from the concrete aggregates evaluation (Section 4.0) were also used to supplement test data for the road-base aggregates evaluation.

The scope of the study did not allow sample collection and laboratory testing of all potential road-base aggregate sources. Existing data and field petrographic and grain-size analyses were used to correlate lithologic and gradation properties to basin-fill units which were not sampled. An important element of this correlation procedure was the use of aerial photographs to help delineate the lateral extent of basin-fill deposits. Photogeologic and field observations ascertained geomorphological and topographical relationships of basin-fill units and the source rock lithology and distribution of predominantly gravelly materials.

3.1.3 Presentation of Results

Results of the road-base aggregates evaluation are presented in the form of text, figures, 1:62,500 scale drawings, and appendices. Drawing 1 shows the locations of all the data points used in the Detailed Aggregate Resources Study. The data points are grouped by study type and assigned categorized map numbers. VSARS data points are designated by map numbers 1 to 199 and correspond to map numbers in the appendix table of the Pine area VSARS report (FN-TR-37-g). DARS data points are assigned map number groups 200 to 299 for trench locations and 300 to 399

for petrographic and grain-size data stop locations. Verification data points are assigned the map number group 400 to 599. For direct reference, appendix Table G-1 converts map number to Pine Verification Report (FN-TR-27-PI-I and II) activity type and number.

Drawing 2 presents the locations of all potential road-base aggregate sources, DARS trenches, DARS field petrographic and grain-size data stops, and selected VSARS data stops in the study area. Geologic unit symbols used in Drawing 2 relate to standard geologic nomenclature whenever possible. A conversion table relating these symbols to the geologic unit nomenclature used in other Ertec reports is contained in Appendix Table F-3.

A solid contact line separates basin-fill and rock units in Drawing 2 to differentiate these two basic material types. All rock contacts are from published data or limited air-photo interpretation and are dashed. Basin-fill contacts are derived from photogeological mapping with limited field reconnaissance and are also dashed.

Classifications of potential sources of basin-fill and crushed-rock road-base aggregates are distinguished by different patterns. Patterns for basin-fill and rock sources of the same classification are similar, with the basin-fill pattern emphasized by a dark background tone.

The appendices contain tables that summarize the basic field data collected during the course of the study and the subsequent

laboratory test procedures and results. Appendices A and B include DARS trench data and petrographic and grain-size analysis data, respectively. Appendix C contains representative trench logs. Appendix Table D-1 presents a laboratory testing flow diagram for the road-base aggregates evaluation. Appendix F includes three tables describing soil classification, caliche development, and geologic unit cross reference.

3.1.4 Classification of Road-Base Aggregates

A classification system was designed to present the most likely locations of potential sources of basin-fill and crushed-rock road-base aggregates. It was developed from an evaluation as well as from an extrapolation of all available data.

This classification system is primarily based on laboratory test results (gradation and abrasion and, to a lesser extent, soundness) and geomorphological and compositional correlations. The classification is presented in hierarchy form; classification of the highest potential source areas is described first and classification of the lowest potential source areas is described last.

Class	Explanation
RBIa	Basin-fill or rock sources containing materials suitable for use as road-base aggregates; based on acceptable laboratory aggregate test results.

Class RBIa includes those source areas where the potential for suitable road-base aggregates is the highest. Each delineated

area has been sampled and tested. In order to assign Class RBIa to a basin-fill deposit, the source must satisfy the overall requirements outlined in Section 3.1.1.

Class	Explanation
RBIb	Basin-fill sources containing materials suitable for use as road-base aggregates; based on correlation with Class RBIa source areas.

Class RBIb basin-fill deposits are correlated to tested RBIa deposits on the basis of limited laboratory sieve analysis data and field observations. Field observations included petrographic and grain-size analyses which provided data on lithology of adjacent source rock and general amounts and lithologies of gravel present in the basin-fill units. Photogeologic interpretations were also used to correlate Class RBIb deposits to RBIa deposits. Specific geomorphological parameters included surface texture, drainage patterns, relative relief, and topographic profiles.

Class	Explanation
RBII	Potential basin-fill sources of materials suitable for use as road-base aggregates; based on photogeologic interpretations, field observations, and limited or inconclusive sieve analysis and/or abrasion data.

Class RBII includes poorly defined basin-fill aggregate sources. Field observations and inconclusive field and laboratory data indicate these deposits may be potentially acceptable for use as road-base aggregate sources.

All classifications are based on limited data. Additional field reconnaissance, testing, and case history studies are needed to confirm adequacy, delimit exact areal boundaries, and refine chemical and physical characteristics.

3.2 SOURCES OF ROAD-BASE AGGREGATES

The potential basin-fill and rock sources defined for use as road-base aggregates in the Pine Valley study area include alluvial fan deposits (Aaf), a stream-channel and terrace deposit (Aal), and quartzite (Qtz), limestone (Ls), and undifferentiated carbonate rock (Cau).

3.2.1 Basin-Fill Sources

All three classes of road-base aggregates, Class RBIa, RBIb, and RBII, are present in the basin-fill deposits of Pine Valley (Drawing 2).

3.2.1.1 Class RBIa

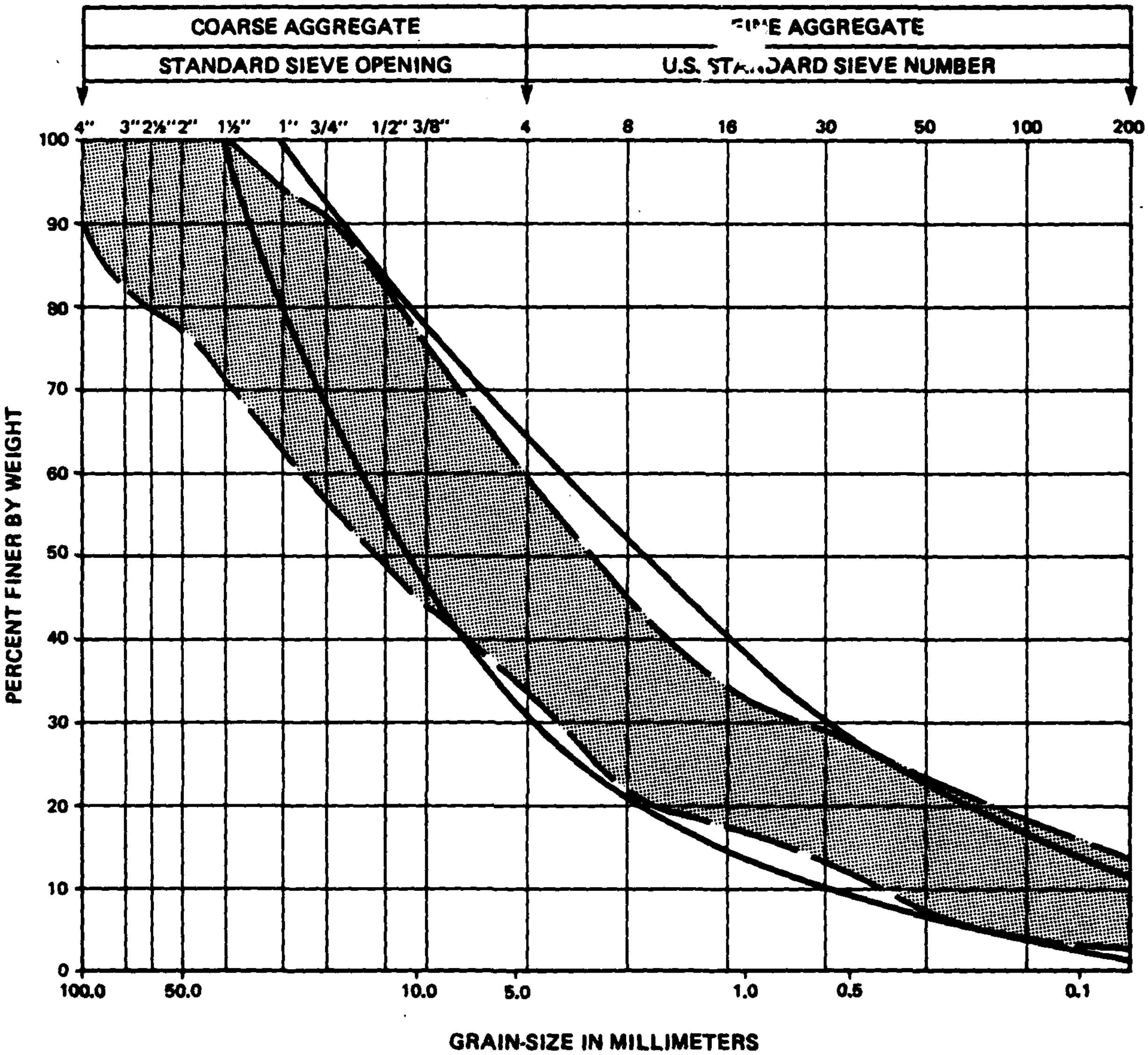
The majority of the Class RBIa sources within the study area are located along the eastern margin of the valley adjacent to the Wah Wah Mountains. Other Class RBIa sources are located on the west side of the study area adjacent to the Indian Peak and The Needles ranges and the eastern and southern boundaries of the Desert Range Experimental Station.

There are 12 Class RBIa basin-fill sources within the study area; 11 are alluvial fan deposits (Aaf) and one is a stream-channel deposit (Aal). Although alluvial fans commonly exhibit a greater degree of caliche development (Stage II and III),

there are no significant compositional or lithological differences between the stream-channel and the alluvial fan units. These basin-fill sources generally consist of poorly to well-graded, subangular to subrounded sandy gravel. The gravel content of these sources ranges from a low of 42 percent to a high of 72 percent, but most deposits contain between 55 and 63 percent gravel. The sand content ranges from a low of 21 percent to a high of 53 percent. The sands are evenly distributed among all appropriate sieve sizes. Silt and clay content (below the overburden layer) ranges from a low of four percent to a high of 18 percent, but most deposits range from six to eleven percent.

Class RBIa basin-fill sources north of Highway 21 consist of carbonates with lesser amounts of quartzite. Sources in the southern portions of the valley, adjacent to the Indian Peak Range and the southern Wah Wah Mountains, consist of volcanic clasts. Sources consisting of quartzite with lesser amounts of carbonates are located immediately south of Highway 21 adjacent to the Wah Wah Mountains. Adjacent to The Needles Range, there are local concentrations of volcanic, carbonate, and quartzite clasts.

The gradation of Class RBIa sources approximates the grain-size distribution requirements stated in Section 3.1.1 (Figure 4). Class RBIa deposits generally share the same gradation characteristics; some cobbles and coarse gravels (oversize material) are present, gravels passing the 1.5- to 0.75-inch sieves are generally deficient, and all other grain sizes, from fine gravel



REQUIRED GRAIN-SIZE DISTRIBUTION ENVELOPE FOR TYPE I CLASS A, ROAD-BASE AGGREGATES (NEVADA STATE DEPARTMENT OF HIGHWAYS, 1976).

GRAIN-SIZE DISTRIBUTION ENVELOPE OF BASIN—FILL AGGREGATES POTENTIALLY SUITABLE FOR ROAD BASE.

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GRAIN-SIZE DISTRIBUTION ENVELOPES
ROAD-BASE AGGREGATES, CLASS RBIa
PINE VALLEY, UTAH

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to fine sand, conform or nearly conform to design gradation requirements. Material greater than 2 inches can be crushed to produce additional aggregates of all sizes. Additional minor processing of all RBIa deposits will be necessary to conform to the gradation requirements.

It has been observed that variations in grain-size gradations occur within a source depending on sample location. In general, gradations within a source are finer near the valley axis and coarser near mountain fronts. Due to access restrictions, samples were generally collected at distal and medial locations within each deposit.

Laboratory abrasion tests performed on samples from all Class RBIa sources have a narrow range of 21.7 to 32.3 percent wear. Laboratory $MgSO_4$ soundness tests performed on a selected group of Class RBIa sources yielded results ranging from 1.9 to 4.3 percent loss for coarse aggregates and from 10.4 to 15.7 percent loss for fine aggregates. These results are generally within the acceptable values for abrasion and soundness.

The areal extent of individual Class RBIa sources ranges from approximately 0.6 to 22.0 mi^2 (1.6 to 57.0 km^2). Excluding the variable stream-channel unit the thickness of these Class RBIa sources has been estimated to be at least 25 feet (7.6 m). Generally, 75 to 90 percent of the material in these deposits will be suitable for use as road-base aggregates.

3.2.1.2 Class RBIb

Class RBIb basin-fill sources consist of 11 alluvial fan (Aaf) deposits that have been correlated to Class RBIa sources and, therefore, are considered to contain material acceptable for use as road-base aggregates. These sources occur on the east side of the valley adjacent to the Wah Wah Mountains, on the west side of the valley adjacent to The Needles Range, and as a small source on the eastern border of the Desert Range Experimental Station. Class RBIb basin-fill sources are generally adjacent to Class RBIa sources.

Since Class RBIb basin-fill sources are correlated to Class RBIa sources, they possess the same general characteristics as the RBIa sources; poorly to well-graded, subangular to subrounded sandy gravel consisting predominantly of carbonate and quartzite clasts with minor amounts of volcanic clasts.

Although variations in grain-size gradations will occur, depending on sample location within the deposit and the proximity of the deposit to its source area, Class RBIb sources are interpreted to have gradation distributions and yields similar to RBIa sources. The areal extent of the RBIb deposits ranges from 0.2 to 8.3 mi^2 (.5 to 21.5 km^2).

3.2.1.3 Class RBII

Class RBII basin-fill aggregate sources are alluvial fan deposits that are potentially acceptable for use as road base. These deposits have been classified on the basis of limited field and laboratory data collected during this and other Ertec studies.

Class RBII consists of nine widely spaced deposits located adjacent to the east and west flanks of Middle Mountain, along the east side of the study area adjacent to the Wah Wah Mountains, and on the west side of the valley adjacent to The Needles and Indian Peak ranges.

Limited laboratory and field data were used to define the Class RBII sources. They are composed predominantly of sandy gravel and gravelly sand with appreciable amounts of carbonate, quartzite, and volcanic clasts. The areal extent of individual RBII deposits ranges from approximately 0.3 to 33 mi^2 (0.8 to 85.5 km^2).

3.2.2 Rock Sources

The study approach used to evaluate road-base aggregates emphasized the analysis of basin-fill deposits and dictated that only previously tested crushed-rock sources be discussed and classified (Drawing 2). As a consequence, other rock units potentially suitable as sources of crushed-rock, road-base aggregates are not included or described in this study.

Class RBIa sources of crushed rock for use as road-base aggregates include quartzite (Qtz), limestone (Ls), and undifferentiated carbonate rocks (Cau). These sources are located at five widely spaced locations within the study area. On the east side of the valley, four Class RBIa crushed-rock sources are located in the Wah Wah Mountains north and south of Highway 21. On the west side of the valley, one Class RBIa crushed-rock

source is located in The Needles Range, 3 miles south of latitude 38° 30' N.

Results of laboratory abrasion tests performed on samples from the Class RBIa crushed-rock samples ranged from 20.1 to 32.9 percent wear. Laboratory $MgSO_4$ soundness test results range from 0.2 to 9.2 percent loss. These test results are well within the acceptable ranges for road-base aggregates.

4.0 CONCRETE AGGREGATES EVALUATION

4.1 STUDY APPROACH

The purpose of the concrete aggregates evaluation is to determine the suitability of aggregates within Pine Valley for use in concrete. To accomplish this, two objectives have been established:

- o Evaluate the basic physical and chemical characteristics of the aggregates; and
- o Determine the concrete making properties of the aggregates.

The study approach required to achieve these objectives included a review of previous Ertec Verification (FN-TR-27-PI-I and II) and aggregate reports (FN-TR-34 and FN-TR-37-g). This data base helped define the scope of the concrete aggregates investigation and included office and field photogeologic and topographic interpretations, field reconnaissance, and collection and laboratory testing of basin-fill and rock samples.

4.1.1 Requirements for Concrete Aggregates

The following requirements for aggregates and concrete (made using these aggregates) were established using criteria from the American Society of Testing and Materials (1979), the "Concrete Manual" prepared by the United States Department of the Interior (1975), and from Milos Polivka (1981, personal communication).

1. Aggregates

   - o Gradation - The aggregate gradation specifications used by the American Society of Testing and Materials (1979, C 33) were selected to evaluate the samples tested. These grading specifications follow.

Coarse Aggregates

Sieve Size	Percent Passing by Weight	Sieve Size	Percent Passing by Weight
2 inches	100	1 inch	100
1.5 inches	95-100	0.75 inch	90-100
1 inch	---	0.5 inch	---
0.75 inch	35-70	0.375 inch	20-55
0.50 inch	---	No.4	0-10
0.375 inch	10-30	No.8	0-5
No.4	0-5		

Fine Aggregates

Sieve Size	Percent Passing by Weight
0.375 inch	100
No.4	95-100
No.8	80-100
No.16	50-85
No.30	25-60
No.50	10-30
No.100	2-10
No.200	

- o Abrasion - Los Angeles Machine abrasion losses for coarse aggregates are not to exceed 50 percent.

- o Soundness - Five-cycle magnesium sulfate ($MgSO_4$) soundness losses are not to exceed 18 percent and 15 percent for coarse and fine aggregates, respectively. Although not a requirement for the evaluation, five-cycle sodium sulfate ($NaSO_4$) soundness tests are performed on samples that failed $MgSO_4$ testing. Resultant losses are not to exceed 12 percent and 10 percent for coarse and fine aggregates, respectively.

- o Reactivity - Aggregates are to be nonreactive to alkali-silica and alkali-carbonate rock tests. Results are incomplete and will be submitted as an addendum to this report.

2. Concrete

- o Compressive Strength - The primary concrete requirement is a 28-day compressive strength equal to or greater than 6500 psi.

- o Static Modulus of Elasticity - Values of 3 to 6 million psi at 28 days required.

- o Splitting Tensile Strength - Ten percent or less of the compressive strength value at 28 days required.
- o Ultimate drying shrinkage - Values of 0.03 to 0.10 percent (300 to 1000 millionths) required.

4.1.2 Data Acquisition and Analysis

4.1.2.1 Office Studies

Office studies for the concrete aggregates evaluation required preliminary basin-fill and rock-unit differentation based upon photogeologic interpretations and published topographic and geologic maps. All available data on basin-fill, grain-size gradations were compiled to estimate gravel content for the defined basin-fill units. All available test data on the aggregate properties of basin-fill and rock units were compiled to select sample locations in units previously tested and found preliminarily acceptable for use as concrete aggregate sources.

4.1.2.2 Field Studies

The field program involved backhoe excavation of 11 trenches selected during office studies and initial field reconnaissance; 10 trenches were excavated to obtain samples of coarse and fine aggregates (gravel and sand), and one was excavated to obtain samples of fine aggregates (sand).

Due to gradation variability in basin-fill deposits, field limits of 30 percent or more gravel and 15 percent or less silt and clay were established as basic aggregate grain-size distribution requirements. Gravel is defined as coarse aggregates which pass the 3.0-inch (75-mm) sieve and are predominantly retained on a No. 4 (4.75-mm) sieve. Silt and clay particles are defined

as material passing through a No. 200 sieve (0.0029-inch [0.075-mm]).

The 10 trenches excavated to collect basin-fill samples for concrete aggregate evaluations were grouped into two sets of five (150 feet apart [46 m]) to characterize individual basin-fill units. A single trench was excavated to investigate a fine aggregate source. Trenches were excavated to depths ranging from 12 to 15 feet (3.7 to 4.6 m). Representative bulk samples averaged 400 pounds (182 kg) per trench. The sample from the fine aggregate trench weighed approximately 800 pounds (364 kg). Two bulk samples of surface rock, weighing about 1200 pounds (545 kg) each, and one additional sample of fine aggregate, weighing about 1200 pounds (545 kg), were collected manually.

Field studies also included 46 petrographic and grain-size data field stops and valley-wide photogeologic field reconnaissance. These analyses were performed to supplement and confirm the office studies and to provide a broader data base for lithologic and gradation correlations of basin-fill units.

4.1.2.3 Laboratory Testing

The laboratory aggregate testing program was performed in two phases. The first phase consisted of standard tests for determining the basic properties of the aggregates and included the following:

- Unit Weights and Voids in Aggregates;
- Standard Specifications for Concrete Aggregates;
- Soundness of Aggregates, Magnesium Sulfate ($MgSO_4$) and Sodium Sulfate ($NaSO_4$);

- o Sieve Analysis by Washing, less than No. 200 fraction;
- o Fineness Modulus;
- o Specific Gravity and Absorption, Coarse and Fine Aggregates;
- o Resistance to Abrasion, Los Angeles Machine;
- o Sieve Analysis, Coarse and Fine Aggregates; and
- o Petrographic Examination of Aggregates for Concrete.

Generally, these tests were performed on aggregates from different locations within the same sources previously tested and identified as the most promising in the VSARS program. This repetitive testing was done to confirm the suitability of aggregates for concrete (see Section 4.1.1, Requirements for Concrete Aggregates). Table 1 lists the number of tests completed in Pine Valley.

The second phase of the testing consisted of an evaluation of the concrete-making properties of the aggregates when used in the following three trial (check) concrete mixes.

Mix 1 - 7.5 sacks (94 pounds per sack) of cement per cubic yard of concrete with 1.5-inches maximum aggregate size.

Mix 2 - 8.5 sacks (94 pounds per sack) of cement per cubic yard of concrete with 1.5-inches maximum aggregate size.

Mix 3 - 8.5 sacks (94 pounds per sack) of cement per cubic yard of concrete with 0.75-inch maximum aggregate size and a superplasticizer.

In all three trial mixes, fly ash, as a pozzolan, replaced 20 percent of the cement by weight. All concrete trial mix design criteria are presented in Table 2. Samples were collected for a

	ASTM STANDARD TEST	AGGREGATE AND CONCRETE TEST DESCRIPTIONS [1]	TOTAL NUMBER OF TESTS*			
			BASIN-FILL		ROCK	
			CA	FA	ROCK	FA
AGGREGATES	C29	UNIT WEIGHT AND VOIDS IN AGGREGATE	2		2	
	C33	STANDARD SPECIFICATIONS FOR CONCRETE AGGREGATE	2		2	
	C88	SOUNDNESS OF AGGREGATE; $Mg SO_4/NaSO_4$	2/–	2/1	2/–	2/–
	C117	SIEVE ANALYSIS BY WASHING, < # 200 FRACTION	4		–	2
	C125	FINENESS MODULUS	–	2	–	2
	C127	SPECIFIC GRAVITY/ABSORPTION, COARSE AGGREGATE	12/4	–/–	12/4	–/–
	C128	SPECIFIC GRAVITY/ABSORPTION, FINE AGGREGATE	–/–	6/2	–/–	6/2
	C131	RESISTANCE TO ABRASION, LOS ANGELES MACHINE	2	–	2	–
	C136	SIEVE ANALYSIS, COARSE AND FINE AGGREGATE	14	12	4	4
	C295	PETROGRAPHIC EXAM. OF AGGREGATES FOR CONCRETE	2	2	2	2
CONCRETE	C39	COMPRESSIVE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS	48		48	
	C138	UNIT WEIGHT, YIELD, AIR CONTENT OF CONCRETE	6		6	
	C143	SLUMP OF PORTLAND CEMENT CONCRETE	8		8	
	C157	LENGTH CHANGE OF HARDENED CEMENT MORTAR AND CONCRETE	60		60	
	C173	AIR CONTENT OF CONCRETE, VOLUMETRIC METHOD	6		6	
	C192	MAKING AND CURING CONCRETE SPECIMENS	6		6	
	C227	POTENTIAL ALKALI-SILICA REACTIVITY, MORTAR-BAR METHOD	–	–	–	1 (IP)
	C469	STATIC MODULUS OF ELASTICITY, POISSONS RATIO OF CONCRETE IN COMPRESSION	48		48	
	C496	SPLITTING TENSILE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS	12		12	
	C684	MAKING AND TESTING ACCELERATED CURE CONCRETE COMPRESSION TEST SPECIMENS	12		12	
	222-1-77 [2]	SELECTING PROPORTIONS FOR NORMAL AND HEAVY WEIGHT CONCRETE	6		6	
	PROP. [3]	POTENTIAL ALKALI-CARBONATE ROCK REACTIVITY, LENGTH CHANGE METHOD	2 (IP)		–	
	C39-65 [4]	COEFFICIENT OF LINEAR THERMAL EXPANSION OF CONCRETE	12 (IP)		12 (IP)	

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (1978)
2. AMERICAN CONCRETE INSTITUTE (1977)
3. MIELENZ (1980) PROPOSED ASTM STANDARD TEST
4. UNITED STATES ARMY CORPS OF ENGINEERS (1977)

(IP) - TEST IN PROGRESS

* BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.

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CONCRETE CONSTRUCTION MATERIALS
AGGREGATE AND TRIAL MIX TESTS
PINE VALLEY, UTAH

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TABLE 1

CONCRETE CONSTITUENTS AND FRESH PROPERTIES	CONCRETE TRIAL MIX DESIGN CRITERIA					
	MIX 1 7.5/1.5 IN.[1]		MIX 2 8.5/1.5 IN.[1]		MIX 3 8.5/0.75 IN.; SUPER.[1]	
	VOLUME	WEIGHT	VOLUME	WEIGHT	VOLUME	WEIGHT
CEMENT, NEVADA TYPE II (LOW ALKALI; FT^3, LBS)	2.87	564	3.25	639	3.25	639
FLY ASH, WESTERN (REPLACES 20% OF CEMENT BY WEIGHT; FT^3, LBS)	0.99	141	1.12	160	1.12	160
SUPERPLASTICIZER (WRDA 19; OZ/CWT)[2]	—	—	—	—	15	—
WATER REDUCER (WRDA 79; OZ/CWT)	5	—	5	—	5	—
AIR ENTRAINMENT ADMIXTURE (DARAVAIR: OZ/CWT, [FT^3])	1.5 - 1.63 [1.08]	—	1.5 - 1.75 [1.08]	—	1.5 - 1.63 [1.08]	—
SLUMP, MAXIMUM (INCHES)	3 - 4		3 - 4		0 - 1[3]	
AIR CONTENT, RANGE (PERCENT)	4 - 6		4 - 6		4 - 6	
WATER/CEMENT RATIO (BY WEIGHT)	0.36		0.32		0.33	
CEMENT FACTOR (SCY)[4]	7.5		8.5		8.5	

1. SACKS OF CEMENT PER CYD / MAXIMUM AGGREGATE SIZE
2. OZ/CWT = OUNCES/100 POUNDS OF CEMENT AND FLY ASH
3. SLUMP BEFORE ADDITION OF SUPERPLASTICIZER
4. SCY = SACKS OF CEMENT/CUBIC YARD OF CONCRETE

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CONCRETE TRIAL MIX DESIGN CRITERIA
PINE VALLEY, UTAH

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TABLE 2

total of four trial mixes; two basin fill (coarse and fine aggregates) and two rock (coarse aggregates) and basin fill (fine aggregates). Material greater than 1.5 inches was crushed to conform to gradation requirements. If necessary, coarse and fine aggregates were processed to conform to gradation requirements.

The following tests were performed to evaluate fresh and hardened properties of concrete made from Pine Valley aggregates:

Fresh Properties

- o Unit Weight, Yield and Air Content of Concrete;
- o Slump of Portland Cement Concrete;
- o Air Content of Concrete, Volumetric Method;
- o Making and Curing Concrete Specimens;
- o Making and Testing Accelerated Cure Concrete Compression Test Specimens; and
- o Selecting Proportions for Normal and Heavyweight Concrete.

Hardened Properties

- o Compressive Strength of Cylindrical Concrete Specimens;
- o Length Change of Hardened Cement Mortar and Concrete;
- o Potential Alkali-Silica Reactivity, Mortar-Bar Method;
- o Static Modulus of Elasticity of Concrete in Compression;
- o Splitting Tensile Strength of Cylindrical Concrete Specimens;
- o Potential Alkali-Carbonate Rock Reactivity, Length Change Method; and
- o Coefficient of Linear Thermal Expansion of Concrete.

The results of all tests summarized in Table 1 are important to the concrete aggregates evaluation, but hardened concrete

properties are considered the most significant (see Section 4.1.1, Requirements for Concrete Aggregates). Although the primary requirement for concrete is a 28-day compressive strength of 6500 psi, one-day (accelerated), seven-day, and 90-day tests were done to determine the range of compressive strength values. In order to compare different aggregate sources, 28-day compressive strengths of Mix 3 were always used.

Occasionally, fresh concrete properties varied from design concrete specifications and may have affected hardened concrete test results. If known or significant, the causative factor and its effect on test results are mentioned in the discussions on sources of concrete aggregates (Sections 4.2.1 and 4.2.2).

The scope of the study did not allow sample collection and laboratory testing of all potential basin-fill and rock concrete aggregate sources. Existing data and field petrographic and grain-size analyses were used to correlate lithologic and gradation properties to basin-fill units which were not sampled. An important element of this correlation procedure was the use of aerial photographs to help delineate the lateral extent of basin-fill deposits. Photogeologic field observations ascertained geomorphological and topographical relationships of basin-fill units and the source rock lithology and distribution of predominantly gravelly materials.

Limited laboratory and field data prevented most correlations of data from tested to untested rock units. Potential aggregate sources were confined to the limits of tested or correlated

outcrops as determined from existing data, limited photogeological interpretation, and field reconnaissance.

4.1.3 Presentation of Results

Results of the concrete aggregates evaluation are presented in the form of text, tables, figures, 1:62,500 scale drawings, and appendices. Drawing 1 is a location map showing the position in the study area of all data points used in the Detailed Aggregate Resources Study. All data points are grouped by study type and assigned categorized map numbers (see Section 3.1.3).

Drawing 3 presents the locations of the potential concrete aggregate sources, basin-fill sources of fine aggregate that were mixed with crushed rock, DARS trenches, DARS field petrographic and grain-size data stops, and select VSARS data stops in the study area. Geologic unit symbols used in Drawing 3 relate to standard geologic nomenclature whenever possible. A conversion table relating these symbols to the geologic unit nomenclature used in other Ertec reports is contained in appendix Table F-3.

A solid contact line separates basin-fill and rock units in Drawing 3 to differentiate these two basic material types. All rock contacts are taken from published data or limited air-photo interpretation and are dashed. Basin-fill contacts are derived from photogeological mapping with limited field reconnaissance and are also dashed.

Classifications of potential basin-fill and rock concrete aggregate sources are distinguished by different patterns.

Patterns for basin-fill and rock sources of the same classification are similar, with the basin-fill pattern emphasized by a dark background tone.

The appendices contain tables that summarize the basic field data collected during the course of the study and the subsequent laboratory test procedures and results. Appendices A and B contain DARS trench data and petrographic and grain-size data, respectively. Appendix C contains representative trench logs. appendix Table D-2 presents a laboratory testing flow diagram for the concrete aggregates evaluation. Appendix E presents the chemical analyses of cement, fly ash, and water used in making all concrete trial mixes. Appendix F includes three tables describing soil classification, caliche development, and geologic unit cross reference.

4.1.4 Classification of Concrete Aggregates

A classification system was designed to present the most likely basin-fill and crushed-rock concrete aggregate sources. It was developed from an evaluation as well as from an extrapolation of all available data. Data include laboratory test results (compressive strength of concrete and grain-size, abrasion, and soundness of aggregates) and geomorphological and compositional correlations.

The classification system groups potential aggregate sources into three categories:

1. Aggregate sources which were used in concrete mixes - Class CA1 and Class CA2;

2. Aggregate sources which were subjected to basic aggregate tests - Class CB; and

3. Untested aggregate sources which were correlated to Classes CA1, CA2, or CB - Class CC1 and Class CC2.

The classification is presented in hierarchy form; classification of the highest potential source areas is described first, and classification of the lowest potential source areas is described last.

Class	Explanation
CA1	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths equal to or greater than 6500 psi using Mix 3 (Section 4.1.2).
CA2	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths less than 6500 psi using Mix 3 (Section 4.1.2).

The Classes CA1 and CA2 describe those specific sources where basin-fill or crushed-rock aggregates have been collected and used in making trial mix batches of concrete. Following appropriate ASTM standards, concrete cylinders containing the collected aggregates were made, cured, and tested for various hardened concrete properties. The class is divided into two categories by 28-day compressive strength test results.

Generally, aggregates from each potential source area have been tested previously during the VSARS program. Confirmation testing that included gradation, abrasion, and soundness tests

was performed when applicable to ensure the continued acceptability of a sample for use in concrete. Abrasion and $MgSO_4$ soundness values do not exceed coarse aggregate requirements specified in Section 4.1.1. Tested samples of fine aggregate used in the concrete trial mixes occasionally have $MgSO_4$ soundness losses exceeding the required 15 percent maximum, however, $NaSO_4$ soundness losses do not exceed 10 percent.

Class	Explanation
CB	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on acceptable laboratory aggregate test results.

The Class CB describes those source areas that have been sampled and tested only for grain-size gradation, abrasion, and $MgSO_4$ soundness. Trial concrete mixes were not made. Gradation, abrasion, and soundness values specified in Section 4.1.1 were used to assign this classification to an aggregate source.

Class	Explanation
CC1	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CA1 or CA2 areas.
CC2	Basin-fill sources of aggregates potentially suitable for use in concrete; based on correlation with Class CB areas.

Untested Class CC deposits are correlated to tested Class CA or CB deposits on the basis of field observations and limited field and laboratory test results. Class CC basin-fill deposits consist of units of the same apparent relative age as Class CA

and CB deposits. Class CC1 rock deposits are additional nearby outcrops of the same unit as Class CA deposits.

Field observations and petrographic and grain-size analyses provided correlative data on lithology of adjacent source rock and lithology and general amounts of gravel present in the basin-fill units. Photogeologic interpretations were also used to correlate Class CC basin-fill deposits to Class CA or CB basin-fill deposits. Specific geomorphological parameters correlated during the procedure included surface texture, drainage patterns, relative relief, and topographic profiles.

All classifications are based on limited data. Additional field reconnaissance, testing, and case history studies are needed to confirm adequacy, delimit exact areal boundaries, and refine chemical and physical properties.

4.2 SOURCES OF CONCRETE AGGREGATES

4.2.1 Basin-Fill Sources

Basin-fill sources of concrete aggregates are grouped into five classes. Deposits defined on the basis of laboratory test data are included in Classes CA1, CA2, and CB. Untested basin-fill deposits correlated to deposits with test data are in Classes CC1 and CC2.

4.2.1.1 Class CA1

There is one Class CA1 basin-fill concrete materials source identified within the study area. This deposit is located on the east side of the valley south of Highway 21 adjacent to the Wah Wah Mountains.

1. The Class CA1 basin-fill source is an alluvial fan deposit (Aaf) located adjacent to the Wah Wah Mountains between latitudes 38°15' N and 38°30' N (Drawing 3). This deposit consists mainly of poorly to well-graded sandy gravel. The gravel ranges from 53 to 63 percent of the deposit (excluding cobbles and boulders) and the sand ranges from 28 to 39 percent. Cobbles and boulders comprise about four percent of the total material within the deposit. Silt and clay comprise seven to 10 percent of the deposit.

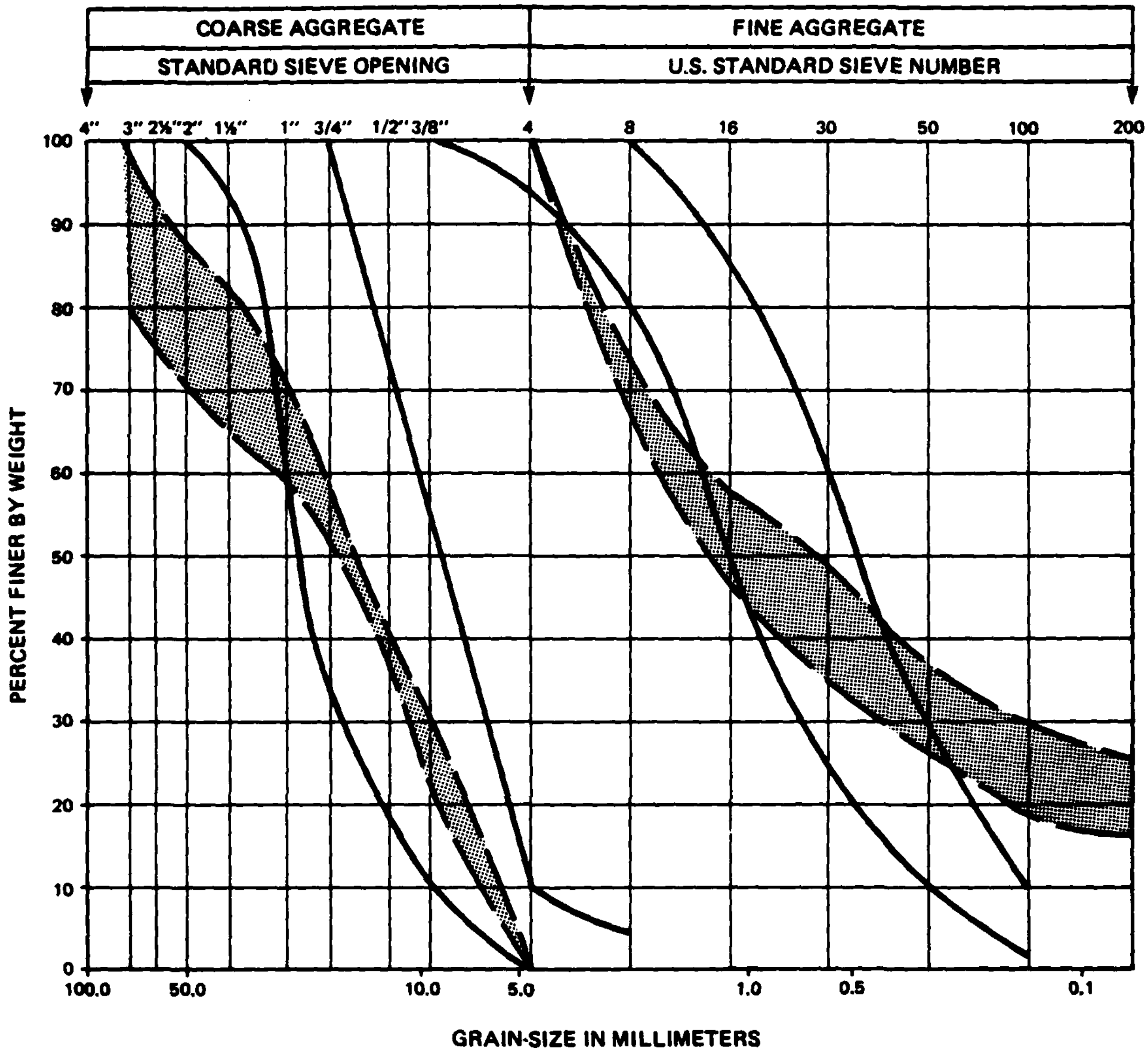
The gravel clasts sampled from the Class CA1 deposit are typically subangular in shape. Approximately 71 percent of the gravel clasts are of satisfactory physical quality; 29 percent are porous, weak, and internally fractured and are of fair physical quality; no gravel is considered to be poor in quality. The collected gravel sample is composed of approximately 13 percent dolomite, 82 percent limestone and dolomitic limestone, four percent quartzite and quartzose sandstone, and one percent chalcedonic chert. About 63 percent of the gravel clasts are partially coated by calcareous material. The dolomite and dolomitic limestone clasts are potentially susceptible to a deleterious degree to the alkali-carbonate rock reaction. The chalcedonic chert present in the sample is potentially susceptible to a deleterious degree to the alkali-silica reaction.

The sand particles from the sampled CA1 deposit are typically subangular in shape and are generally similar in composition and quality to the gravel clasts within the deposits. Approximately 63 percent of the sampled sand particles are satisfactory in physical quality; 27 percent are porous, weak, or internally fractured and are fair in physical quality; and about 10 percent are soft, highly porous particles and are of poor quality. The

collected sand sample is composed of approximately 77 percent dolomite and limestone, five percent quartz and quartzose sandstone, and 18 percent feldspar, other sandstone, and coating material. Dolomitic limestones and calcitic dolomites are potentially susceptible to a deleterious degree to the alkali-carbonate rock reaction. Rhyolites and chalcedonic chert are potentially susceptible to the alkali-silica reaction.

Although the percentages of coarse aggregates passing the 1-inch to No. 4 sieves within the Class CA1 deposit conform to the design gradation requirements (Figure 5), the percentage of gravels passing the 1- to 2-inch sieves is below the design requirements. The percentages of fine aggregates do not conform to design gradation requirements except for the sand passing the No. 16 and No. 30 sieves. There is a deficiency of coarse sand passing the No. 4 to No. 16 sieves and an excess of fine sand passing the No. 50 to No. 200 sieves. Processing will be necessary to bring the deposit within gradation requirements. Oversize clasts are present and can be crushed to produce additional aggregates of all sizes. Variations in grain-size gradations will occur within the deposit depending on proximity to the source area. In general, this deposit is relatively finer grained near the valley axis and coarser grained adjacent to the mountain fronts.

A coarse aggregate sample from this Class CA1 deposit was subjected to laboratory abrasion and $MgSO_4$ soundness tests and yielded losses of 25.9 and 3.5 percent, respectively. These



REQUIRED GRAIN-SIZE DISTRIBUTION ENVELOPES FOR COARSE AND FINE AGGREGATES USED IN CONCRETE (AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1978, C 33; THE RECOMMENDED GRADATIONS FOR AGGREGATES WITH 1.5 AND 0.75 INCH MAXIMUM SIZE ARE COMBINED INTO ONE ENVELOPE).

GRAIN-SIZE DISTRIBUTION ENVELOPES OF BASIN–FILL COARSE AND FINE AGGREGATES POTENTIALLY SUITABLE FOR CONCRETE.

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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREGATE, PI-A- (7-11)
PINE VALLEY, UTAH

12 JUN 81 FIGURE 8

values for abrasion and soundness are well within acceptable values for coarse concrete-construction material use. The fine aggregate sample from this Class CA1 deposit was subjected to both $MgSO_4$ and $NaSO_4$ soundness tests. The sample failed the $MgSO_4$ soundness test with a 19.2 percent loss but passed the $NaSO_4$ soundness test with a 4.5 percent loss.

Concrete (Mix 3) made using the aggregates from the Class CA1 deposit had a 28-day compressive strength of 7140 psi and a 90-day compressive strength of 8030 psi. Concrete trial Mixes 1 and 2 yielded 28-day compressive strengths of 4830 psi and 5055 psi, respectively (Table 3). Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, drying shrinkage) are also included in Table 3. All test results for hardened concrete are within or exceed the requirements mentioned in Section 4.1.1 except for the tensile strength value of Mix 3.

The areal extent of the Class CA1 deposit is approximately 1.8 mi^2 (4.7 km^2). It is estimated that the material sampled from this deposit and described above extends to a depth of at least 25 feet (7.6 m). It is also estimated that this deposit has a yield of 60 to 70 percent after gradation deficiencies, handling, poor-quality constituents, and silt and clay losses.

4.2.1.2 Class CA2

There is one Class CA2 basin-fill concrete materials source identified within the study area. This deposit is located on

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES					
			SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STANDARD TES
BASIN–FILL	PI-A- (7 - 11)	MIX 1 7.5/1.5 IN.	3.5	1.5	149.8	.39	7.58	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICITY (PSI x 10^6)
								SPLITTING TENSILE STRENGTH, (PSI)
								DRYING SHRINKAGE, ASTI (PERCENT)
	PI-A- (7 - 11)	MIX 2 8.5/1.5 IN.	2.5	2.0	149.5	.36	8.52	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICITY (PSI x 10^6)
								SPLITTING TENSILE STRENGTH (PSI)
								DRYING SHRINKAGE, AST (PERCENT)
	PI-A- (7 - 11)	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	0 BEF. 3.5 AFT.	2.2	147.5	.28	8.66	COMPRESSIVE STRENGTH, (PSI)
								CHORD MODULUS OF ELASTICIT (PSI x 10^6)
								SPLITTING TENSILE STRENGT (PSI)
								DRYING SHRINKAGE, AS (PERCENT)

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TENSILE ST CYLINDERS. DRYING SHRINKA MENS; TIMETABLE INCLUDES A

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE			
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
MPRESSIVE STRENGTH, ASTM C 39 (PSI)	2400	4130	4830	6235
MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.55	4.45	5.07	5.61
ING TENSILE STRENGTH, ASTM C 496 (PSI)			430	

DRYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.024	0.037	0.045	0.048

ASTM STANDARD TEST [4]	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
OMPRESSIVE STRENGTH, ASTM C 39 (PSI)	2665	4250	5055	6105
MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.51	5.C	4.89	5.48
TING TENSILE STRENGTH, ASTM C 496 (PSI)			460	

DRYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.021	0.032	0.036	0.037

ASTM STANDARD TEST [4]	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
OMPRESSIVE STRENGTH, ASTM C 39 (PSI)	3410	5775	7140	8030
MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.63	4.56	4.99	5.40
TTING TENSILE STRENGTH, ASTM C 496 (PSI)			720	

DRYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.027	0.042	0.048	0.050

PRESSIVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED
NDERS. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-
; TIMETABLE INCLUDES A SEVEN DAY MOIST CURE.

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CONCRETE TRIAL MIX TEST RESULTS
PI-A- (7 - 11)
PINE VALLEY, UTAH

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the east side of the valley north of Highway 21 adjacent to the Wah Wah Mountains.

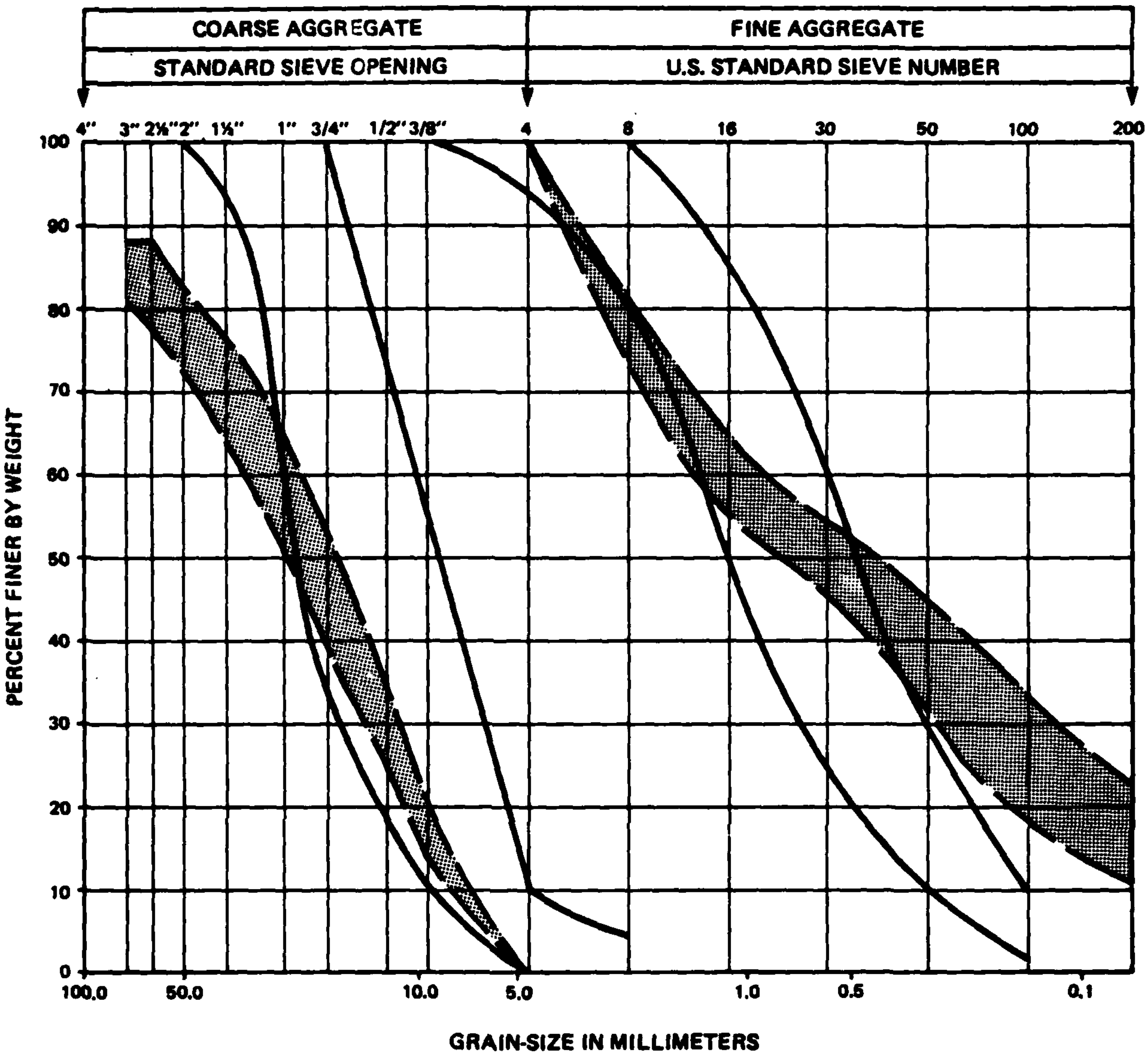
1. The Class CA2 basin-fill source is an alluvial fan deposit (Aaf) located adjacent to the Wah Wah Mountains between latitudes 38°30' N and 38°45' N (Drawing 3). This deposit consists mainly of poorly to well-graded sandy gravel. The gravel ranges from 60 to 72 percent of the deposit (excluding cobbles and boulders) and the sand ranges from 25 to 35 percent. Cobbles and boulders comprise about five to 14 percent of the total material within the deposit. Silt and clay comprise three to six percent of the deposit.

The gravel clasts sampled from the Class CA2 deposit are typically subangular to subrounded in shape. Approximately 76 percent of the gravel clasts are of satisfactory physical quality; 22 percent are porous, weak, and internally fractured and are of fair physical quality; and about two percent are soft and highly porous and are of poor quality. The collected gravel sample is composed of approximately 48 percent dolomite, 50 percent limestone and dolomitic limestone, and two percent chalcedonic chert, calcareous coating material, and weathered andesite tuff. About 60 percent of the gravel clasts are partially or completely coated by firm to soft calcareous material. The dolomite and dolomitic limestone clasts are potentially susceptible to a deleterious degree to the alkali-carbonate rock reaction. Minor chalcedonic chert and volcanic tuff material are potentially susceptible to a deleterious degree to the alkali-silica reaction.

The sand particles from the sampled Class CA2 deposit are typically subangular to subrounded in shape and are generally similar in composition and quality to the gravel clasts within

the deposit. Approximately 69 percent of the sand particles sampled are satisfactory in physical quality; 23 percent are porous, weak, or internally fractured and are of fair physical quality; and about eight percent are soft, highly porous particles and are of poor quality. The sampled sand is composed of approximately 76 percent dolomite and limestone, 10 percent rhyolite and chalcedonic chert, six percent quartz, and eight percent feldspar, weathered sandstone, and coating material. All the sand is considered to be potentially susceptible to a deleterious degree to the alkali-carbonate rock reaction. Minor chert and volcanic tuff are potentially susceptible to a deleterious degree to the alkali-silica reaction.

Within the Class CA2 deposit, the percentages of coarse aggregates passing the 1-inch to No. 4 sieves conform to the design gradation requirements (Figure 6). However, the percentages of gravels passing the 2- to 1-inch sieves are deficient. The percentages of fine aggregates do not conform to design gradation requirements except for the sand passing the No. 16 to No. 30 sieves. There is a deficiency of coarse sand passing the No. 4 to No. 16 sieves and an excess of fine sand passing the No. 30 to No. 200 sieves. Processing will be necessary to bring the deposit within gradation requirements. Oversize clasts are present and can be crushed to provide additional aggregates of all sizes. Variations in grain-size gradations will occur within the deposit depending on proximity to the source area. In general, this deposit is relatively finer grained near the valley axis and coarser grained adjacent to the mountain fronts.



REQUIRED GRAIN-SIZE DISTRIBUTION ENVELOPES FOR COARSE AND FINE AGGREGATES USED IN CONCRETE (AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1978, C 33; THE RECOMMENDED GRADATIONS FOR AGGREGATES WITH 1.5 AND 0.75 INCH MAXIMUM SIZE ARE COMBINED INTO ONE ENVELOPE).

GRAIN-SIZE DISTRIBUTION ENVELOPES OF BASIN--FILL COARSE AND FINE AGGREGATES POTENTIALLY SUITABLE FOR CONCRETE.

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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREGATES, PI-A- (32-36)
PINE VALLEY, UTAH

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FIGURE 8

A coarse aggregate sample from this Class CA2 deposit was subjected to laboratory abrasion and $MgSO_4$ soundness tests and yielded losses of 26.1 and 1.6 percent, respectively. These values for abrasion and soundness are well within acceptable values for coarse concrete-construction material use. The fine aggregate sample from this Class CA2 deposit was subjected to the $MgSO_4$ soundness test and passed with an 11.4 percent loss.

Concrete (Mix 3) made using the aggregates from the Class CA2 deposit had a 28-day compressive strength of 6240 psi and a 90-day compressive strength of 8440. Concrete trial Mixes 1 and 2 yielded 28-day compressive strengths of 5535 psi and 5880 psi, respectively (Table 4). Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, drying shrinkage) are also included in Table 4. Generally, test results for hardened concrete are within the requirements mentioned in Section 4.1.1.

The areal extent of the Class CA2 deposit is approximately 4.2 mi^2 (10.9 km^2). It is estimated that the material sampled from this deposit and described above extends to a depth of at least 25 feet (7.6 m). It is also estimated that this deposit has a yield of 65 to 70 percent after gradation deficiencies, handling, poor-quality constituents, and silt and clay losses.

4.2.1.3 Class CB

Class CB basin-fill aggregate sources are alluvial and stream-channel deposits that have been sampled and laboratory tested

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES: SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/ CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STANDARD TEST
BASIN–FILL	PI-A- (32 - 36)	MIX 1 7.5/1.5 IN.	2.5	1.7	150.2	0.38	7.57	COMPRESSIVE STRENGTH, AS (PSI)
								CHORD MODULUS OF ELASTICITY, (PSI x 10^6)
								SPLITTING TENSILE STRENGTH, (PSI)
								DRYING SHRINKAGE, ASTM (PERCENT)
	PI-A- (32 - 36)	MIX 2 8.5/1.5 IN.	2.5	2.5	149.5	0.33	8.52	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICITY (PSI x 10^6)
								SPLITTING TENSILE STRENGTH, (PSI)
								DRYING SHRINKAGE, AST (PERCENT)
	PI-A- (32 - 36)	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	0 BEF. 4.5 AFT.	3.3	148.3	0.28	8.66	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICIT (PSI x 10^6)
								SPLITTING TENSILE STRENGTH (PSI)
								DRYING SHRINKAGE, AST (PERCENT)

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TENSILE STRE CYLINDERS. DRYING SHRINKAG MENS; TIMETABLE INCLUDES A S

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE			
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
OMPRESSIVE STRENGTH, ASTM C 39 (PSI)	2705	4570	5535	6300
D MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.52	4.73	5.45	5.84
TTING TENSILE STRENGTH, ASTM C 496 (PSI)			510	

DRYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.021	0.028	0.033	0.035

COMPRESSIVE STRENGTH, ASTM C 39 (PSI)	2860	4820	5880	6845
RD MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.82	4.85	5.39	6.02
ITTING TENSILE STRENGTH, ASTM C 496 (PSI)			510	

DRYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.031	0.038	0.043	0.046

COMPRESSIVE STRENGTH, ASTM C 39 (PSI)	2825	5525	6240	8440
RD MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.22	4.74	5.05	5.79
ITTING TENSILE STRENGTH, ASTM C 496 (PSI)			515	

DRYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.031	0.044	0.051	0.055

MPRESSIVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED LINDERS. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-NS; TIMETABLE INCLUDES A SEVEN DAY MOIST CURE.

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CONCRETE TRIAL MIX TEST RESULTS
PI-A- (32 36)
PINE VALLEY, UTAH

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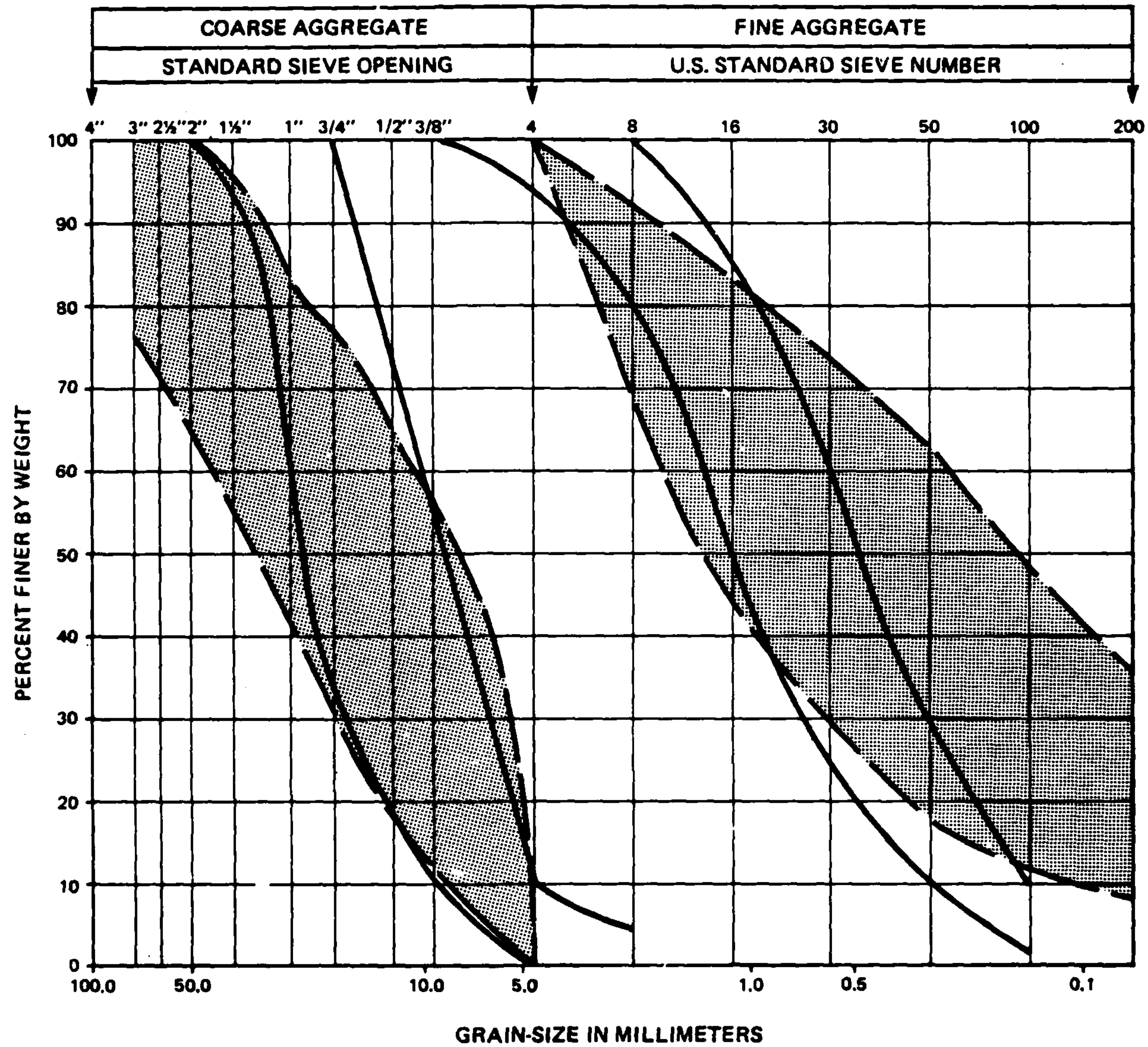
and, on the basis of test results, are considered to be potential sources of concrete aggregates. Class CB deposits have not been used in concrete trial mixes. Test results show that these deposits contain at least 30 percent gravel clasts of all sizes (3-inch to No. 4 sieve sizes), have less than 50 percent abrasion wear, and where applicable, have less than 18 percent loss when subjected to a $MgSO_4$ soundness test.

There are 10 alluvial fan and one stream-channel Class CB sources in the Pine Valley study area. Most of the alluvial fans are located on the east side of the valley adjacent to the Wah Wah Mountains. The one stream-channel deposit is located in the southern portion of the study area.

Class CB basin-fill deposits generally consist of poorly to well-graded, subangular to subrounded gravelly sand and sandy gravel. The gravel content of most Class CB deposits ranges from about 42 to 72 percent, sand ranges from 21 to 53 percent, and the silt content ranges from four to 18 percent. Depending on location within the valley, most deposits are composed of either carbonate and quartzite clasts or volcanic clasts. There are no significant differences between the alluvial fan deposits and the stream-channel deposit.

Generally, coarse aggregates conform to Class CB design gradation requirements (Figure 7). The percentages of gravels passing the 2- to 1-inch sieves are deficient. Oversize material is available and can be crushed to provide additional aggregates of all sizes. The percentages of sand passing the No. 4 to No. 30



REQUIRED GRAIN-SIZE DISTRIBUTION ENVELOPES FOR COARSE AND FINE AGGREGATES USED IN CONCRETE (AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1978, C 33; THE RECOMMENDED GRADATIONS FOR AGGREGATES WITH 1.5 AND 0.75 INCH MAXIMUM SIZE ARE COMBINED INTO ONE ENVELOPE).

GRAIN-SIZE DISTRIBUTION ENVELOPES OF BASIN—FILL COARSE AND FINE AGGREGATES POTENTIALLY SUITABLE FOR CONCRETE.

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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREATE, CLASS CB
PINE VALLEY, UTAH

12 JUN 81

FIGURE 7

sieves generally meet design gradation requirements. The percentages of fine sand passing the No. 50 to No. 200 sieves are generally excessive. Variations in grain-size gradations will occur within the deposit depending on proximity to the source area. In general, the deposits are relatively finer grained near the valley axis and coarser grained near the mountain fronts.

Laboratory abrasion tests performed on samples from all Class CB deposits resulted in fairly low percent wear values ranging from 21.7 to 32.3 percent. $MgSO_4$ soundness tests performed on the coarse aggregates from five of the Class CB samples resulted in values ranging from 1.9 to 4.3 percent loss. $MgSO_4$ soundness test results on fine aggregate samples ranged from 10.4 to 15.7 percent loss.

The areal extent of individual Class CB deposits ranges from 0.6 to 22.0 mi^2 (1.6 to 57.0 km^2). Except for the stream-channel deposit, it is estimated that the material sampled from these deposits extends to a depth of at least 25 feet (7.6 m) and will have a yield of 60 to 70 percent.

4.2.1.4 Class CC1

The Class CC1 sources within the study area are located on the east side of the valley adjacent to the Wah Wah Mountains north and south of Highway 21. They consist of two alluvial fan deposits that have been correlated to the Class CA1 and CA2 deposits on the basis of geomorphological and compositional similarities.

The Class CC1 deposits are therefore considered to be potential source of concrete aggregate consisting of poorly graded, subangular to angular sandy gravel of generally satisfactory physical quality. The lithology of the deposits is predominantly quartzite, limestone, and dolomite with trace amounts of other rock types. The areal extent of the Class CC1 deposits are 0.5 and 1.6 mi^2 (1.3 and 4.1 km^2).

4.2.1.5 Class CC2

Class CC2 basin-fill aggregate sources are alluvial fan deposits that have been correlated to Class CB concrete aggregate sources on the basis of geomorphological and compositional similarites. These deposits are therefore assumed to contain material similar in size and composition to Class CB deposits. Class CC2 deposits are located along the east side of the valley adjacent to the Wah Wah Mountains, along the east boundary of the Desert Range Experimental Station, and south of Highway 21 adjacent to The Needles Range. Individual deposits have areal extents ranging from 0.2 to 7.7 mi^2 (0.5 to 19.9 km^2).

4.2.2 Rock Sources

Rock concrete aggregate sources are grouped into three classes. Rock defined on the basis of laboratory test data are included in Classes CA1 and CB. Class CC1 contains rocks correlated to tested rock units.

4.2.2.1 Class CA1

Two Class CA1 crushed-rock coarse aggregate sources were delineated within the study area. These rock sources are located on

the east side of the study area in the Wah Wah Mountains. The Class CA1 rock source north of Highway 21 is an undifferentiated carbonate rock unit (Cau); the source south of Highway 21 is a quartzite rock unit (Qtz). Both were sampled during this study. The fine aggregates used in conjunction with the Class CA1 rocks are from two basin-fill units. One deposit is located along the east boundary of the Desert Range Experimental Station about 4.5 miles (7.2 km) northwest of the northern rock sample location and the other was manually sampled in a Class CB unit 0.25 mile (0.4 km) southwest of the southern rock stop.

The northern Class CA1 rock sample used in the concrete trial mix consisted of dark- to medium-gray, hard, fine-grained to microcrystalline, massive dolomite. When crushed, this rock produced fragments that were generally angular and ranged from approximately equidimensional to thick-tabular.

Approximately 12 percent of the crushed-rock fragments are internally fractured and are classified as only fair in physical quality. About 87 percent of the crushed-rock fragments are of satisfactory physical quality. Calcareous caliche occurring as individual particles makes up the majority of material classified as poor in physical quality and constitute only one percent of the crushed rock sample. Weathering is present on the surface of the sample with partial coatings of weak, porous calcareous caliche. The rock is not similar to dolomites that are susceptible to a deleterious degree to the alkali-carbonate reaction and may need further investigation to determine the

deleterious degree of reaction. No substances known to be susceptible to a deleterious degree to the alkali-silica reaction are present in the sample.

The sand sample used in conjunction with the Class CA1 rock source is from an older lacustrine deposit (Aol) and consists of poorly graded, well-rounded to angular gravelly sand. Approximately 81 percent of the sand particles are of satisfactory physical quality; 18 percent are moderately weathered, weak, porous, or internally fractured and are of fair quality; and one percent consists of soft, highly porous, poor-quality particles confined to the finest size fractions. The sand is composed of 43 percent dolomite and limestone, 30 percent volcanic rock fragments, 22 percent quartz, and five percent chalcedonic chert, feldspar, heavy minerals, and biotite mica. Many particles are partially coated by firm to soft encrustations of calcareous material that commonly include fine sand. Dolomite and dolomitic limestone are a major constituent in all of the sand-size fractions and may be susceptible to a deleterious degree to the alkali-carbonate reaction. The volcanic particles and chalcedonic cherts are susceptible to a deleterious degree to the alkali-silica reaction.

The crushed-rock aggregates from the Class CA1 deposit were subjected to a laboratory abrasion test which yielded a result of 20.1 percent wear. A $MgSO_4$ soundness test performed on the crushed rock yielded a result of 0.19 percent loss. These results are well within the maximum allowable values for abrasion

wear and soundness loss for coarse aggregate concrete construction materials. The fine aggregate used in conjunction with the crushed rock passed the $MgSO_4$ soundness test with a 12.9 percent loss.

A 28-day compressive strength of 7470 psi was obtained from concrete trial Mix 3 using Class CA1 crushed rock (Table 5). This same mix had a 90-day compressive strength of 8870 psi. Concrete Mixes 1 and 2, using Class CA1 crushed rock, produced 28-day compressive strengths of 5605 psi and 6125 psi, respectively. Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, drying shrinkage) are also included in Table 5. Test results for hardened concrete are generally within the required limits stated in Section 4.1.1.

The southern Class CA1 rock sample used in a concrete trial mix consisted of a gray-white to pale-pink, hard to moderately hard, massive quartzose sandstone. When crushed, this rock produced fragments that were generally angular with edges and corners slightly rounded as a result of attrition incidental to processing and handling. The particle shape ranges from approximately cubic to thick-tabular or platy.

About 60 percent of the crushed-rock fragments are of satisfactory physical quality. Approximately 40 percent of the crushed-rock fragments are internally fractured, porous, or platy and are of fair physical quality. No fraction of the crushed rock is considered to be poor in physical quality. Only

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES: SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STANDARD TEST
LEDGE ROCK AND SAND	PI-R-2 & PI-FA-2	MIX 1 7.5/1.5 IN.	4.0	5.0	147.4	0.36	7.35	COMPRESSIVE STRENGTH, AS (PSI)
								CHORD MODULUS OF ELASTICITY (PSI x 10^6)
								SPLITTING TENSILE STRENGTH, (PSI)
								DRYING SHRINKAGE, ASTM (PERCENT)
	PI-R-2 & PI-FA-2	MIX 2 8.5/1.5 IN.	4.0	6.0	147.2	0.32	8.28	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICITY (PSI x 10^6)
								SPLITTING TENSILE STRENGTH (PSI)
								DRYING SHRINKAGE, AST (PERCENT)
	PI-R-2 & PI-FA-2	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	2.0 BEF. 8.0 AFT.	5.0	146.4	0.32	8.36	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICIT (PSI x 10^6)
								SPLITTING TENSILE STRENGTH (PSI)
								DRYING SHRINKAGE, AS (PERCENT)

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TENSILE STR CYLINDERS. DRYING SHRINKAG MENS; TIMETABLE INCLUDES A

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE: 1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2025	4125	5605	7020
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.17	4.61	5.64	6.55
NG TENSILE STRENGTH, ASTM C 496 (PSI)			575	

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
RYING SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.014	0.021	0.025	0.029

ASTM STANDARD TEST	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
MPRESSIVE STRENGTH, ASTM C 39 (PSI)	2160	4220	6125	7370
MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.49	5.04	5.65	6.33
TING TENSILE STRENGTH, ASTM C 496 (PSI)			596	

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
DRYING SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.020	0.029	0.031	0.034

ASTM STANDARD TEST	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
MPRESSIVE STRENGTH, ASTM C 39 (PSI)	2950	5715	7470	8870
MODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.95	4.93	5.69	6.19
TING TENSILE STRENGTH, ASTM C 496 (PSI)			645	

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
DRYING SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.023	0.030	0.035	0.038

RESSIVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED
DERS. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-
TIMETABLE INCLUDES A SEVEN DAY MOIST CURE.

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CONCRETE TRIAL MIX TEST RESULTS
PI-R-2 AND PI-FA-2
PINE VALLEY, UTAH

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trace amounts of other constituents other than quar are present as sand grains or intergranular material. No constituents known or thought to be susceptible to deleterious cement-aggregate reactions were found in the sample.

The sand sample used in conjunction with the Class CA1 rock source is from an alluvial fan deposit (Aaf) which consists of poorly graded, well-rounded to angular sandy gravel. Approximately 66 percent of the sand particles are of satisfactory physical quality and 29 percent are soft or highly porous and are fair in physical quality. Only five percent of the sand particles are poor in physical quality. Most of the poor-quality materials are granules of calcareous coating material. The sand is comprised of 79 percent dolomite and limestone, five percent quartz, nine percent sandstones, six percent feldspars, heavy minerals, biotite mica, coating material, and a trace of rhyolite. Most of the particles are heavily coated by firm to soft, finely porous, and absorptive calcareous material, commonly intermingled with fine sand. Particles of rhyolites that are potentially susceptible to a deleterious degree to the alkali-silica reaction constitute negligible proportions of the sand. Dolomites and limestones are potentially susceptible to a deleterious degree to the alkali-carbonate reaction.

The crushed-rock aggregates from the Class CA1 deposit were subjected to a laboratory abrasion test which yielded a result of 30.4 percent wear. A $MgSO_4$ soundness test performed on the crushed rock yielded a result of 0.91 percent loss. These results are well within the maximum allowable values for abrasion

wear and soundness loss for coarse aggregate concrete construction materials. The fine aggregate used in conjunction with the crushed rock passed the $MgSO_4$ soundness test with a 12.5 percent loss.

A 28-day compressive strength of 8205 psi was obtained from concrete trial Mix 3 using Class CA1 crushed rock (Table 6). This same mix had a 90-day compressive strength of 9685 psi. Concrete Mixes 1 and 2, using Class CA1 crushed rock, produced 28-day compressive strengths of 6045 psi and 6610 psi, respectively. Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, drying shrinkage) are also included in Table 6. Test results for hardened concrete are generally within the required limits stated in Section 4.1.1.

4.2.2.2 Class CB

Class CB crushed-rock sources are rock units that have been sampled and laboratory tested and on the basis of the test results, are considered to be potential concrete aggregate sources. Class CB rocks have not been used in concrete trial mixes.

Two Class CB limestone (Ls) rock sources within the study area are located in the Wah Wah Mountains north of Highway 21 between latitude 38°30' N and 38°45' N. One additional source of Class CB rock is a quartzite (Qtz) unit located in The Needles Range just south of latitude 38°30' N. The two limestone unit samples in the Wah Wah Mountains are light to dark-gray, fine to medium-grained, thinly bedded to massive limestone. The quartzite unit

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES: SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STANDARD TEST
LEDGE ROCK AND SAND	PI-R-3 & PI-FA-3	MIX 1 7.5/1.5 IN.	3.0	2.3	146.8	0.38	7.55	COMPRESSIVE STRENGTH, AS (PSI)
								CHORD MODULUS OF ELASTICITY (PSI x 10^6)
								SPLITTING TENSILE STRENGTH, (PSI)
								DRYING SHRINKAGE, ASTM (PERCENT)
	PI-R-3 & PI-FA-3	MIX 2 8.5/1.5 IN.	3.0	2.5	148.7	0.35	8.62	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICITY (PSI x 10^6)
								SPLITTING TENSILE STRENGTH (PSI)
								DRYING SHRINKAGE, AST (PERCENT)
	PI-R-3 & PI-FA-3	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	1.0 BEF. 4.0 AFT.	3.5	145.3	0.33	8.51	COMPRESSIVE STRENGTH, A (PSI)
								CHORD MODULUS OF ELASTICIT (PSI x 10^6)
								SPLITTING TENSILE STRENGTH (PSI)
								DRYING SHRINKAGE, AS (PERCENT)

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TENSILE STR CYLINDERS. DRYING SHRINKAG MENS; TIMETABLE INCLUDES A

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE				
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS	
RESSIVE STRENGTH, ASTM C 39 (PSI)	2735	4830	6045	7150	
DDULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	2.01	2.69	2.94	3.34	
G TENSILE STRENGTH, ASTM C 496 (PSI)			515		
YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.024	0.040	0.054	0.067
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2770	4995	6610	7670	
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	1.97	2.79	3.15	3.51	
NG TENSILE STRENGTH, ASTM C 496 (PSI)			675		
RYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.033	0.041	0.056	0.065
IPRESSIVE STRENGTH, ASTM C 39 (PSI)	3535	7075	8205	9685	
IODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	2.19	3.24	3.48	3.88	
ING TENSILE STRENGTH, ASTM C 496 (PSI)			680		
IYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.032	0.046	0.064	0.073

ISSIVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED
ERS. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-
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TABLE 6

in The Needles Range is a light-brown to white, thin- to thick-bedded, fine- to medium-grained orthoquartzite with interbedded sandstone and shale near the base and top of the unit.

Laboratory abrasion tests performed on the Class CB crushed rocks yielded results ranging from 30.5 to 37.1 percent wear. When subjected to a $MgSO_4$ soundness test, the crushed rocks exhibited a range of values from 1.6 to 9.2 percent loss. All results are well below the maximum allowable abrasion wear of 50 percent and soundness loss of 18 percent for coarse aggregate used as concrete construction material.

4.2.2.3 Class CC1

Class CC1 potential concrete aggregate sources are untested rock outcrops of the undifferentiated carbonate rock (Cau) and quartzite (Qtz) units. Published geologic maps were used to delineate these extensive and widespread outcrops. These sources are part of the same geologic unit as the Class CA1 sources and have essentially the same lithologies; limestone, dolomitic limestone, and quartzite.

5.0 CONCLUSIONS

Results of the Detailed Aggregate Resources Study indicate that there are sufficient quantities of aggregates available for the construction of the MX missile system in the Pine Valley study area.

Good- to high-quality basin-fill and crushed-rock coarse aggregates are present along the east side of the valley. Sufficient quantities of fair-quality, fine aggregates are present in basin-fill deposits in the valley. After shelter layouts are finalized, potential borrow areas can be delineated based on the results of this study.

Although most rock will supply acceptable coarse aggregates, limited sources are delineated in this study. Sufficient quantities of basin-fill aggregates within the valley will probably make processing of crushed-rock aggregates unnecessary.

As discussed in the report, field studies placed an arbitrary cut-off limit of a minimum of 30 percent gravel for the source to be considered for road-base or concrete aggregates. Nevertheless, basin-fill deposits with less than 30 percent gravel are also probably potentially suitable for use as aggregates. However, yield from such sources will be low and extensive processing and/or blending will be required to satisfy the gradation requirements.

5.1 ROAD-BASE AGGREGATES

5.1.1 Class RBIa Sources

Twelve basin-fill deposits consisting of good- to high-quality coarse aggregates acceptable for road base have been located within the study area. All of the deposits are alluvial fan units (Aaf) confined to the east side of the valley. Their total areal extent is approximately 70 mi^2 (181 km^2).

Gradation results indicate that, where sampled, the deposits approximate ASTM standards and DARS requirements. Sand and fine gravel sizes are within design gradation requirements. Percentages of gravels passing the 1.5- to 0.75-inch sieves are generally deficient. Crushing and blending can be used to bring individual deposits within design gradation requirements. In addition, grain-size variations will occur depending on sample location within the deposit. Generally, finer grained material can be obtained nearer the valley axis and coarser grained material can be obtained near mountain front source areas.

Abrasion and soundness results on tested samples are generally within ASTM standards and DARS requirements.

Five good- to high-quality coarse aggregate crushed-rock sources which are acceptable for use as road-base aggregates have been delineated within the study area. These sources are fairly extensive outcrops of quartzite (Qtz), limestone (Ls), and undifferentiated carbonate rocks (Cau). Samples from these rock sources yielded test results for abrasion and soundness

well within acceptable ranges as specified by ASTM standards and DARS requirements.

5.1.2 Class RBIb Sources

Eleven basin-fill deposits within the study area are defined as potential sources of good- to high-quality coarse aggregates suitable for use as road-base construction material. Geomorphological and compositional similarities were used to correlate these units to tested RBIa deposits. The units are all alluvial fan units (Aaf) confined to the east side of the valley. Their total areal extent is approximately 40 mi^2 (104 km^2).

5.1.3 Class RBII Sources

Several potential road-base aggregate sources defined by limited field and laboratory data are present throughout the study area. All deposits are alluvial fans, consist predominantly of sandy gravel or gravelly sand, and are compositionally similar to Class RBIa and RBIb deposits. These deposits have a total areal extent of approximately 66 mi^2 (171 km^2).

5.2 CONCRETE AGGREGATES

5.2.1 Class CA1 Sources

One basin-fill deposit consisting of good- to high-quality aggregates that produced concrete with 28-day compressive strengths equal to or greater than 6500 psi has been delineated within the study area. Chord modulus of elasticity, splitting tensile strength, and drying shrinkage results generally conform to the standard concrete requirements.

Gradation results indicate that, where sampled, the deposits approximate ASTM standards and DARS requirements. The percentages of coarse gravels passing the 1- to 2-inch sieves are deficient. Generally, the percentages of medium and fine gravels (1-inch to No. 4) conform to gradation specifications. The fine aggregate samples generally contain a deficiency of sand passing the No. 16 sieve and an excess of fine sand passing the No. 50 to No. 200 sieves. Processing of the basin-fill deposits can be used to bring gradations within design requirements. Crushing of oversize material will produce additional aggregates of all sizes. In addition, variations in grain-size gradation will occur within the deposit depending on proximity to the source area. Aggregates are relatively finer grained near the valley axis and coarser grained near the mountain fronts.

Abrasion and soundness tests performed on coarse aggregates from the Class CA1 deposit are within specified ASTM and DARS requirements. The fine aggregates within the deposit are generally of lower quality (high $MgSO_4$ soundness losses) but results are inconclusive regarding their use as concrete construction material. The Class CA1 basin-fill deposit is an alluvial fan unit (Aaf) located on the east side of the valley. Its total areal extent is approximately 2 mi^2 (5.2 km^2).

Two Class CA1 crushed-rock sources (Cau and Qtz) were delineated on the east side of the study area. The crushed-rock coarse aggregates from these sources have acceptable abrasion and soundness test results, and the local sand (fine aggregates) used in the mixes had acceptable $MgSO_4$ soundness losses.

5.2.2 Class CA2 Sources

One basin-fill source delineated on the east side of the study area produced concrete with a 28-day compressive strength of less than 6500 psi. Abrasion and soundness tests performed on the coarse aggregates and soundness on the fine aggregates from this deposit yielded test results within acceptable ranges as specified by ASTM standards and DARS parameters.

5.2.3 Class CB Sources

Eleven basin-fill deposits consisting of good- to high-quality coarse aggregates potentially acceptable for use as concrete construction material were delineated within the study area. These deposits are all alluvial fan units (Aaf) and are confined to the east side of the valley. Their total areal extent is approximately 65 mi^2 (168 km^2). No concrete trial mixes were made, but gradation, abrasion, and soundness test results on all basin-fill and rock samples are within acceptable ranges as specified by ASTM standards and DARS requirements.

5.2.4 Class CC1 Sources

Two basin-fill alluvial fan units in the study area are classified as potential sources of concrete aggregates. The units were correlated to Class CA1 sources based on geomorphological and compositional similarities. These deposits have a total areal extent of approximately 2 mi^2 (5.2 km^2).

5.2.5 Class CC2 Sources

Several alluvial units located along the east side of the valley are classified as potential sources of concrete aggregates.

Units were correlated to Class CB sources on the basis of geomorphological and compositional similarities. They have a total areal extent of approximately 18 mi^2 (46.6 km^2).

6.0 RECOMMENDATIONS FOR FUTURE STUDIES

The conclusions of this Detailed Aggregate Resources Study of Pine Valley, as enumerated in Section 5.0, are based on limited field and laboratory test results. However, the results presented in this report provide sufficient data for selecting potential borrow areas. After selection of the borrow areas, more extensive studies are required to further determine the characteristics of the aggregates.

6.1 SOURCES OF ROAD-BASE AGGREGATES

It is recommended that additional field exploration (backhoe or drilling) and detailed laboratory testing be performed. The laboratory tests should consist of sieve analysis, resistance to abrasion, CBR, and other appropriate tests as deemed necessary by the designers.

6.2 SOURCES OF CONCRETE AGGREGATES

It is recommended that additional field investigations (backhoe or drilling) and detailed laboratory testing be performed. The aggregate samples should be subjected to the following tests:

- o Sieve Analysis;
- o Resistance to Abrasion;
- o Soundness;
- o Specific Gravity and Absorption; and
- o Petrographic Examination of Aggregates for Concrete.

In addition, the following detailed tests using concrete made from these aggregates should be performed:

- o Compressive Strength;
- o Splitting Tensile Strength;
- o Flexural Strength;
- o Shrinkage;

- o Thermal Expansion;
- o Modulus of Elasticity;
- o Potential Alkali-Silica Reactivity;
- o Potential Alkali-Carbonate Rock Reactivity; and
- o Resistance of Concrete to Rapid Freezing and Thawing.

In addition, it is recommended that concrete trial mixes with different size aggregates and admixtures be made in order to assess the variation in compressive strength, durability, shrinkage, and thermal properties of concrete.

Verification studies (FN-TR-27-PI-I and II) performed in Pine Valley indicate that potential for sulfate attack of soils on concrete ranges from "negligible" to "mild." However, it is recommended that additional studies be made to further evaluate the potential for sulfate attack of soils on concrete and to determine the type of cement to be used in concrete.

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APPENDIX A

SUMMARY OF FIELD AND LABORATORY TEST DATA

FIELD AND LABORATORY TEST DATA

Field observations and laboratory test data on samples collected at selected stations are presented in Table A-1. Field stations were established at various locations throughout the study area where detailed descriptions of potential basin-fill, fine aggregate, and crushed-rock sources were recorded. Detailed explanations for the column headings of Table A-1 are as follows:

COLUMN HEADING	EXPLANATION
MAP NUMBER	Map numbers are sequentially arranged identifiers of field stations occupied during the course of the aggregate study.
FIELD STATION	These designations are internal DARS identifiers of all field stations. Each one consists of a two-letter valley abbreviation followed by the letter A (aggregate trench), FA (fine aggregate trench), or R (ledge rock).
LOCATION	The location column lists the geographic portion of the valley in which the field station is located (e.g., NE-northeast).
GEOLOGIC UNIT	The geologic unit listed is a term used to differentiate basin-fill deposits based on geomorphology and rock units based on existing geologic maps. A geologic unit cross reference, outlining all units used, is included as Table F-3.
MATERIAL DESCRIPTION	Material descriptions are based on either field or laboratory USCS classifications using appropriate ASTM standards for basin-fill deposits and existing references and Travis (1955) for rock units. Coarse and fine aggregate gradations used in concrete trial mix designs are included at the end of each concrete aggregate trench group.
USCS SYMBOL	Appropriate field or laboratory ASTM standards are used to classify sampled

material. The Unified Soil Classification System is used in this study. Table F-1 contains detailed information on the USCS.

FIELD OBSERVATIONS

Boulders and/or Cobbles

The estimated occurrence of boulders and cobbles is based on an appraisal of the entire deposit. Cobbles have an intermediate diameter of 3 to 12 inches (8 to 30 cm); boulders have an intermediate diameter of 12 inches (30 cm) or more. Because of sample-size limitations, boulders were not generally sampled. Cobbles were representatively sampled for concrete aggregate evaluations but only generally sampled for road-base aggregate evaluations. Field observations of boulders and cobbles are important considerations for in-situ gradations only. Number percentages are equated to the following equivalent dry weight terms:

Rare	-	1 - 4 percent
Few	-	5 - 20 percent
Some	-	> 20 percent

Gravel

Coarse aggregate particles that pass a 3-inch (76-mm) sieve but are predominantly retained on a No. 4 (4.75 mm) sieve.

Sand

Fine aggregate particles that almost entirely pass a No. 4 sieve but are predominantly retained on a No. 200 (0.075 mm) sieve.

Fines

Soil particles that pass a No. 200 sieve (silt and clay).

Overburden Thickness (Feet)

Surficial soil overlying a usable aggregate deposit. Material generally consists of silt and sand with low concentrations of gravel. Numbers presented indicate thickness of deposit in feet.

Total Trench Depth (Feet)

Depth, in feet, of trench excavation used to collect aggregate samples. Depth followed by the letter R indicates that depth below which soil strength exceeded excavation capability. The common conditions for refusal (R) are calcium carbonate accumulation (caliche) and/or presence of oversized material.

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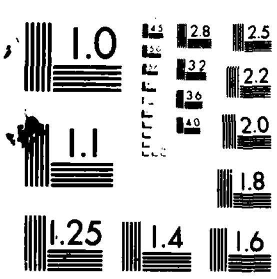

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

<u>Deleterious Materials (Material/Depth/ Stage)</u>

Deleterious materials are substances that are potentially detrimental to concrete in service. Substances that may be present include: organic impurities, low density materials (ash, vesicles, pumice, cinders), amorphous silica (opal, chert, chalcedony), volcanic glass, caliche and clay coatings, mica, gypsum, pyrite, chlorite, friable materials, and aggregates that may react chemically or be affected chemically by other external influences. The most common deleterious material is calcium carbonate accumulation (caliche). When it is abundant, the interval(s) at which it occurs and the stage of development (Table F-2) are listed. Caliche can occur disseminated throughout a deposit, as lenses, and as discrete layers. The depth space is left blank when caliche is present throughout the deposit.

<u>Plasticity (Index)</u>

Plasticity index (PI) is the range of water content, expressed as a percentage of the weight of the oven-dried soil (less than No. 40 sieve material), through which a soil behaves plastically . It is defined as the liquid limit minus the plastic limit. Field terms used to approximate plasticity index range include the following.

Plasticity	PI	Wet Consistency
Slight	(4-15)	Slightly sticky; after pressure, soil adheres to both thumb and finger but comes off cleanly. Does not appreciably stretch.
Medium	(15-30)	Sticky; after pressure, soil adheres to both thumb and finger and tends to stretch somewhat before pulling apart from either digit.
High	(>30)	Very sticky; after pressure, soil adheres strongly to both digits and is markedly stretched when digits are separated.

<u>Hardness</u>

Hardness determination is a field test used to identify materials that are soft or poorly bonded by estimating their resistance to crushing by impact with a

rock hammer. Classification terms used include:

Soft	Hammer point indents deeply with firm blow.
Moderately Hard	Hammer point indents only shallowly with firm blow.
Hard	Hammer breaks hand-held sample with one firm blow.
Very Hard	Hammer breaks intact sample with many blows.

Weathering — Weathering is defined as any changes in color, texture, strength, chemical composition, or other properties of rock due to the effects of various atmospheric conditions. Field terms used to classify degree of weathering include: fresh, slight(ly), moderate(ly), or very weathered.

LABORATORY TEST DATA

Sieve Analysis (ASTM C 136) — A sieve analysis is the determination of the proportions of particles existing within certain size ranges in granular material by separation on sieves of different size openings, expressed as a weight percent of the total sample. Numbers presented represent the percent of the sample passing through the stated sieve size. Sieve sizes include: 3-inch (75-mm), 2 1/2-inch (63-mm), 2-inch (50-mm), 1 1/2-inch (38.1-mm), 1-inch (25-mm), 3/4-inch (19-mm), 1/2-inch (12.5-mm), 3/8-inch (9.5-mm), No. 4 (4.75 mm), No. 8 (2.36 mm) No. 16 (1.18 mm) No. 30 (0.6 mm), No. 50 (0.3 mm), No. 100 (0.15 mm), No. 200 (0.075 mm).

Specific Gravity and Absorption (ASTM C 127 and 128) — In general, specific gravity is defined as the ratio of the weight in air of a unit volume of material to the weight in air of an equal volume of water. Absorption is the process by which a liquid is drawn into and tends to fill permeable pores in a porous solid body, also, the increase in weight of a porous

solid body resulting from the penetration of a liquid into its permeable pores. Specific definitions of bulk, bulk saturate-surface-dry (SSD), and apparent specific gravity, as well as absorption are contained in ASTM-E 12-70 and C 125, respectively.

Fineness Modulus

Fineness modulus is an empirical factor obtained by adding the total percentages of a sample of aggregate, retained on each of a specified series of sieves, and dividing the sum by 100.

Unit Weight

Unit weight is the weight of a unit volume of dry, rodded aggregate, commonly expressed as pounds per cubic foot (pcf).

Abrasion Test (ASTM C 131)

The abrasion test is a method for testing resistance to wearing away by rubbing and friction, by placing a specified quantity of aggregates in a steel drum (the Los Angeles testing machine), rotating the drum 500 times, and determining the percent of material worn away.

Soundness Test (ASTM C 88)

Soundness tests are used to determine resistance to large or permanent volume changes of aggregates by placing samples in saturated solutions of magnesium or sodium sulfate. The test furnishes information useful in studying resistance to weathering action, particularly when adequate service records of the material tested are not available. For concrete aggregate tests, magnesium sulfate soundness tests are run first. If the material fails this test, sodium sulfate soundness tests are performed.

Petrographic Examination (ASTM C 295)

A petrographic examination is a procedure used to identify the physical and chemical properties of aggregates that have a bearing on the quality of the material in consideration of its intended use. Typical properties analyzed include: description and classification of constituents, relative amounts of constituents, particle coatings, rock type, particle condition

and particle shape, texture and structure, color, mineral composition and heterogeneities, and presence of constituents known to cause deleterious chemical reactions in concrete.

Alkali Reactivity

Alkali-Silica ASTM C 227 — A potential alkali-silica reactivity test evaluates the susceptibility of cement-aggregate combinations to expansive reactions involving the alkalies sodium and potassium by measurement of the increase (or decrease) in length of mortar bars containing the combination during storage under prescribed conditions of test.

Alkali-Carbonate ASTM Proposed Standard — A potential alkali-carbonate reactivity test evaluates the susceptibility of cement-aggregate combinations to expansive reactions involving the carbonates of dolomite (in certain calcitic dolomites and dolomitic limestones) by measurement of the increase (or decrease) in length of concrete specimens (prisms) containing the combination during storage under prescribed conditions of test. This test is a proposed ASTM standard and has not been formally approved by the American Society of Testing and Materials.

AGGREGATE USE CLASSIFICATION

Road Base Aggregate

RBIa — Basin-fill or rock sources containing materials suitable for use as road-base aggregates; based on acceptable laboratory aggregate test results.

RBIb — Basin-fill sources containing materials suitable for use as road-base aggregates; based on correlation with Class RBIa areas.

RB II — Potential basin-fill sources of materials suitable for use as road-base aggregates; based on photogeologic interpretations, field observations, and limited or inconclusive sieve analysis and/or abrasion data.

Concrete Aggregate	CA1	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths equal to or greater than 6500 psi.
	CA2	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths less than 6500 psi.
	CB	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on acceptable laboratory aggregate test results.
	CC1	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CA1 or CA2 source areas.
	CC2	Basin-fill sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CB source areas.
	FA	Basin-fill sources containing fine aggregates used with crushed-rock samples for certain concrete trial mixes.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)		
							GRAVEL	SAND	FINES
201	PI-A-1	Pine Valley, E	Aaf	Sandy Gravel	GP-GM	Few/ Few			
202	PI-A-2	Pine Valley, E	Aaf	Sandy Gravel	GW-GM	Few/ Few			
203	PI-A-3	Pine Valley, E	Aaf	Gravelly Sand	SW-SM	Few/ Few			
	PI-A-(1, 2,3,)			Sandy Gravel	GW-GM				
204	PI-A-4	Pine Valley E	Aaf	Sandy Gravel	GP-GM	-/Few			
205	PI-A-5	Pine Valley, E	Aaf	Sandy Gravel	GM	Many/ Occ.			
206	PI-A-6	Pine Valley, E	Aaf	Sandy Gravel	GP-GM	Occ./ Few			
	PI-A-(4, 5,6)			Sandy Gravel	GP-GM				
207	PI-A-7	Pine Valley, E	Aaf	Sandy Gravel	GP-GM	Few/-			
208	PI-A-8	Pine Valley, E	Aaf	Sandy Gravel	GP-GM	Occ./ Few			
209	PI-A-9	Pine Valley, E	Aaf	Sandy Gravel	GP-GM	Occ./ Few			
210	PI-A-10	Pine Valley, E	Aaf	Sandy Gravel	GP-GM	Occ./ Many			
211	PI-A-11	Pine Valley, E	Aaf	Sandy Gravel	GP-GM	-/Few			

FIELD OBSERVATIONS													
OF ER S / FINES	OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	SIEVE ANALYS						
							3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.
	2.0	13.0	Caliche/ - /II	Slight					100	98.6	94.3	88.6
	3.0	12.0	Caliche/ - /I,II	Slight					100	98.7	94.4	90.6
	2.5	13.0	Caliche/7-8/I,II	Slight					100	97.0	93.9	90.3
									100	96.4	94.1	90.0
	2.0	14.0	Caliche/ - /II,III	Slight			100	96.3	96.3	93.4	86.7	80.7
	2.0	13.0	Caliche/ - /II,III	Slight				100	99.0	95.9	89.2	82.0
	2.0	13.0	Caliche/ - /II,III	Slight			100	97.3	97.3	97.0	91.1	85.
									100	98.6	91.8	84.
	2.5	13.0	Caliche/1-2.5'/III	Slight			100	96.8	96.8	94.8	91.1	86.
	2.0	13.0	Caliche/1-2'/III	Slight			100	87.6	85.6	84.1	78.3	72.
	2.0	13.0	Caliche/1-2/II,III	Slight			87.3	84.8	80.1	78.0	73.7	69.
	2.0	13.0	Caliche/1-2,4-5, 10-11/II-III	Slight			87.2	84.5	83.3	81.5	75.4	69
	1.0	13.0	Caliche/5-8'/II	Slight			96.3	96.3	94.8	90.5	83.4	76

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LABORATORY TEST DATA

	…ALYSIS, ASTM C 136 (PERCENT PASSING)										SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128							
											COARSE AGGREGATE				FINE AGGREGATE			
											SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)
	3/4 IN.	1/2 IN.	3/8 IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT	
	88.6	79.3	72.4	52.7	38.3	28.0	21.2	15.8	11.6	8.6								
	90.6	81.4	74.4	54.6	39.6	28.2	19.9	12.9	8.2	5.5								
	90.3	83.4	77.1	57.8	39.6	25.2	16.3	10.3	6.9	5.2								
	90.0	80.7	72.9	51.0	34.2	23.0	16.1	11.1	7.7	5.6								
	80.7	68.6	58.9	39.3	29.2	22.2	18.5	15.6	13.2	10.7								
	82.0	73.6	66.0	46.7	35.4	27.3	23.2	20.2	17.6	14.5								
	85.5	73.0	60.7	37.4	26.5	20.2	17.1	14.7	12.4	11.3								
	84.5	71.9	61.4	39.6	26.8	20.2	17.1	14.9	12.9	11.0								
1	86.2	76.7	67.0	46.8	31.6	21.9	16.5	12.9	10.4	8.0								
3	72.7	62.4	53.4	36.7	26.4	20.3	16.4	13.3	11.1	9.4								
7	69.3	61.4	54.5	35.3	25.0	18.2	14.4	11.6	9.6	7.5								
4	69.4	60.0	52.5	36.3	27.4	20.9	16.6	13.0	10.1	7.6								
4	76.3	66.5	59.9	45.5	33.8	25.6	20.2	16.0	12.8	9.8								

FINENESS MODULUS (PERCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
			$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
										RBIa,CI
										RBIa,CI
										RBIa,CI
		27.7								
										RBIa,C
										RBIa,C
										RBIa,C
		29.3								
										RBIa,
										RBIa,
										RBIa,
										RBIa,
										RBIa,

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SUMMARY OF FIELD A
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PINE VALLEY

12 JUN 81

TABLE A

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WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
		COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
		$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
									RBIa,CB
									RBIa,CB
									RBIa,CB
	27.7								
									RBIa,CB
									RBIa,CB
									RBIa,CB
	29.3								
									RBIa,CA1
									RBIa,CA1
									RBIa,CA1
									RBIa,CA1
									RBIa,CA1

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MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

SUMMARY OF FIELD AND LABORATORY TEST DATA
PINE VALLEY, UTAH

12 JUN 81 TABLE A-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)		
							GRAVEL	SAND	FINES
	PI-A-(7,8, 9,10,11)			1.5in-0.75in					
	PI-A-(7,8, 9,10,11)			0.75in-No.4					
	PI-A-(7,8, 9,10,11)			Blend (1.5in- No.4)					
	PI-A-(7,8, 9,10,11)			No.4-No.200					
212	PI-A-12	Pine Valley, E	Aaf	Sandy Gravel	GW	-/Few			
213	PI-A-13	Pine Valley, E	Aaf	Sandy Gravel	GM	-/Few			
214	PI-A-14	Pine Valley, E	Aaf	Sandy Gravel	GW-GM	-/Few			
	PI-A-(12, 13,14)			Sandy Gravel	GP-GM				
215	PI-A-15	Pine Valley, C	Aaf	Gravelly Sand	SP-SM	- / -	15	75	10
216	PI-A-16	Pine Valley, C	Aaf	Gravelly Sand	SP-SM	- / -	15	75	10
217	PI-A-17	Pine Valley, C	Aaf	Sandy Gravel	GW-GM	Many/ Many			
218	PI-A-18	Pine Valley, C	Aaf	Sandy Gravel	GW-GM	Many/ Many			
	PI-A-(17,18)			Sandy Gravel	GW-GM				

FIELD OBSERVATIONS						SIEVE ANALYSIS, A[illegible]						
OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.	½ IN
									100	67.7	9.5	2.
											100	77.
									100	84	55	40
2.0	13.0	Caliche/ - /I	Slight			94.4	92.5	85.4	81.4	70.4	63.1	53.
2.0	14.0	Caliche/6-7, 10-11/II	Slight			100	95	94.5	92.6	84.7	79.0	68.
1.5	13.0	Caliche/ - /II	Slight			91.4	84.3	79.7	78.4	69.5	64.9	57
						89.8	89.8	88.5	83.8	75.4	69.2	61
1.0	14.0	Caliche/1-4/II	Slight									
1.0	14.0	Caliche/1-4/II	Slight									
1.0	13.0	Caliche/1-3/III	Slight			96.9	96.9	92.9	88.2	78.7	73.9	6[illegible]
1.0	13.0	Caliche/1-3/III	Slight			94.6	89.0	86.0	79.4	72.2	66.9	5[illegible]
						95.5	91.5	90.3	85.0	78.6	72.7	[illegible]

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ASTM C 136 (PERCENT PASSING)									LABORATORY TEST DATA								
									SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128								FINENESS MODULUS (PERCENT)
									COARSE AGGREGATE				FINE AGGREGATE				
									SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)	
½ IN.	3/8 IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT		
.4	1.3	0.7							2.67	2.70	2.75	1.06					
.5	56.6	5.2							2.74	2.75	2.77	0.44					
0	29	3															
		100	87.6	59.1	38.2	20.6	10.5	3.7					2.56	2.62	2.73	2.33	2.84
3.8	48.4	36.0	30.1	24.9	20.2	12.5	6.8	4.3									
8.2	61.9	49.3	43.6	39.0	35.7	30.4	23.9	17.6									
7.1	51.3	40.0	33.6	29.2	25.8	20.5	14.8	10.4									
1.4	56.2	44.7	37.5	32.4	28.2	21.5	15.2	10.6									
62.7	53.6	36.2	29.2	22.8	16.9	11.1	7.3	5.3									
58.6	52.8	37.8	31.6	25.4	19.6	13.0	8.4	5.8									
63.4	55.9	37.1	29.9	22.9	17.5	11.8	7.8	5.6									

NENESS DDULUS RCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
			$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
	104.2									
	107.6	25.9	3.45							
2.84					19.19	4.49				
										RBIa,CB
										RBIa,CB
										RBIa,CB
		27.4								
										RBIa,CB
										RBIa,CB
		24.1								

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SUMMARY OF FIELD AND LA
TEST DATA
PINE VALLEY, UTA

12 JUN 81 TABLE A-1

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WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
		COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
		$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
4.2									
7.6	25.9	3.45							
				19.19	4.49				
									RBIa,CB
									RBIa,CB
									RBIa,CB
	27.4								
									RBIa,CB
									RBIa,CB
	24.1								

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MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

SUMMARY OF FIELD AND LABORATORY TEST DATA
PINE VALLEY, UTAH

12 JUN 81 TABLE A-1 PAGE 2 OF 6

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT) GRAVEL	SAND	FINES
219	PI-A-19	Pine Valley, C	Aaf	Sandy Gravel	GP-GM	Many/-	70	30	10
220	PI-A-20	Pine Valley, S	Aaf	Sandy Gravel	GP	Many/ Occ.			
221	PI-A-21	Pine Valley, S	Aaf	Sandy Gravel	GM	Many/ Occ.			
222	PI-A-22	Pine Valley, S	Aaf	Sandy Gravel	GM	Many/ Occ.			
	PI-A-(20, 21,22)			Sandy Gravel	GW-GM				
223	PI-A-23	Pine Valley, S	Aaf	Gravelly Sand	SM	- / -	23	57	20
224	PI-A-24	Pine Valley, S	Aaf	Sandy Gravel	GP	-/Few			
225	PI-A-25	Pine Valley, S	Aaf	Sandy Gravel	GP-GM	- / -			
	PI-A-(24,25)			Sandy Gravel	GP-GM				
226	PI-A-26	Pine Valley, NE	Aaf	Sandy Gravel	GP-GM	Occ./ Few			
227	PI-A-27	Pine Valley, NE	Aaf	Sandy Gravel	GP-GM	Occ./ Few			
228	PI-A-28	Pine Valley, NE	Aaf	Sandy Gravel	GP-GM	-/Few			
	PI-A-(26, 27,28)			Sandy Gravel	GP-GM				

N OF INER LES T)	FIELD OBSERVATIONS						SIEVE ANAL					
FINES	OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	3/ I
10	1.0	5.0(R)	Caliche/1-5/III	Slight								
	0.5	13.0	Caliche/0.5-4.5/ III	Slight			86.7	84.8	81.6	78.4	68.0	61
	1.0	13.0	Caliche/1-3/III	Slight			86.3	84.8	82.9	75.9	65.1	58
	1.0	13.0	Caliche/1-3.5/III	Slight			83.1	76.6	70.5	66.6	59.6	5
							89.0	83.0	76.2	73.2	64.9	5
20	5.0	14.0	Caliche/1-5/II	Slight								
	1.0	13.0	Caliche/1-3/II	Slight			100	94.9	90.4	88.4	77.9	7
	5.0	13.0	Caliche/1-5/II				97.3	90.5	86.4	83.3	81.5	6
							90.4	87.5	85.7	78.1	70.5	6
	1.0	12.0	Caliche/1-2/II	Slight			100	98.1	97.1	94.5	83.0	7
	1.0	13.5	Caliche/1-2/II	Slight			100	98.1	93.1	91.0	83.7	
	1.0	13.0	Caliche/1-2/II	Slight			97.7	97.7	95.3	94.4	86.7	
							100	98.1	94.1	92.5	84.3	

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LABORATORY TEST DATA

ANALYSIS, ASTM C 136 (PERCENT PASSING)											SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128							
											COARSE AGGREGATE				FINE AGGREGATE			
											SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)
	3/4 IN.	1/2 IN.	3/8 IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT	
0	61.6	54.6	49.2	37.9	31.7	24.0	15.7	8.2	5.2	4.1								
.1	58.6	52.2	48.6	40.9	36.5	32.3	27.6	21.8	17.9	14.4								
.6	54.6	49.2	46.1	39.8	36.5	33.2	28.7	21.7	16.4	12.7								
.9	59.4	54.1	49.5	41.0	34.9	29.7	24.3	18.0	14.0	11.2								
.9	73.3	65.2	60.5	50.8	45.4	34.8	22.8	11.7	6.6	4.7								
.5	68.7	62.7	58.7	49.5	44.6	35.2	26.5	19.5	12.8	8.5								
.5	65.6	57.8	53.7	45.1	40.2	26.5	17.6	10.7	7.0	5.1								
.0	73.0	59.3	49.5	32.3	23.2	18.1	15.1	12.6	10.2	7.9								
.7	77.9	68.2	59.8	40.8	29.7	21.3	16.6	13.0	10.0	7.3								
.7	79.3	68.1	59.2	41.0	30.4	23.1	18.7	15.0	11.7	8.5								
.3	77.1	66.0	56.7	38.5	26.4	19.6	15.7	12.6	9.8	7.4								

ABSORP. (PERCENT)	FINENESS MODULUS (PERCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		
				COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
				$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
											RBI
											RBI
											RBI
											RBI
			27.3								
											RBI
											RB
											RB
			25.0								
											R
											R
											R
			29.3								

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WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
		COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
		$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
									RBIa,CB
									RBIa,CB
									RBIa,CB
									RBIa,CB
	27.3								
									RBIa,CB
									RBIa,CB
									RBIa,CB
	25.0								
									RBIa,CB
									RBIa,CB
									RBIa,CB
	29.3								

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DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

SUMMARY OF FIELD AND LABORATORY TEST DATA
PINE VALLEY, UTAH

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)		
							GRAVEL	SAND	FINES
229	PI-A-29	Pine Valley, NE	Aaf	Sandy Gravel	GW-GM	-/Few			
230	PI-A-30	Pine Valley, NE	Aaf	Sandy Gravel	GW-GM	-/Many			
231	PI-A-31	Pine Valley, NE	Aaf	Sandy Gravel	GW-GM	- / -			
	PI-A-(29, 30,31)			Sandy Gravel	GW-GM				
232	PI-A-32	Pine Valley, NE	Aaf	Sandy Gravel	GP	Many/ Many			
233	PI-A-33	Pine Valley, NE	Aaf	Sandy Gravel	GP	Many/ Many			
234	PI-A-34	Pine Valley, NE	Aaf	Sandy Gravel	GP-GM	Many/ Many			
235	PI-A-35	Pine Valley, NE	Aaf	Sandy Gravel	GP	Many/ Many			
236	PI-A-36	Pine Valley, NE	Aaf	Sandy Gravel	GP	Many/ Many			
	PI-A-(32,33, 34,35,36)			1.5in-0.75in					
	PI-A-(32,33, 34,35,36)			0.75in-No.4					
	PI-A-(32,33, 34,35,36)			Blend (1.5in-No.4)					
	PI-A-(32,33, 34,35,36)			No.4-No.200					

FIELD OBSERVATIONS						SIEVE ANALYSIS,					
OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.
1.0	13.5	Caliche/1-2/II	Slight				100	99.0	92.5	83.8	76.2
1.0	11.0	Caliche/1-3, 10-11/II	Slight			88.7	84.8	77.1	70.4	62.4	57.7
1.0	12.0	Caliche/1-13, 11/ II,III	Slight			90.8	89.0	89.0	87.1	83.3	78.6
						100	97.0	94.2	89.5	80.1	73.8
1.0	13.0	Caliche/1-2.5/II	Slight			86.2	86.2	82.6	74.9	62.1	52.6
1.0	13.0	Caliche/1-2.5, 8-9/II	Slight			95.3	95.3	92.4	84.0	75.4	68.2
1.0	12.5	Caliche/1-2/II	Slight			86.7	85.0	83.7	74.5	61.3	52.2
1.0	12.0(R)	Caliche/1-3/II	Slight			91.7	85.8	82.5	80.4	73.3	64.6
1.0	13.0	Caliche/1-2/II	Slight			91.7	91.7	88.1	84.0	73.7	64.6
									100	52.1	3.3
										100	98.4
									100	76	51

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LABORATORY TEST DATA

ALYSIS, ASTM C 136 (PERCENT PASSING)										SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128							
										COARSE AGGREGATE				FINE AGGREGATE			
										SPECIFIC GRAVITY				SPECIFIC GRAVITY			
3/4 IN.	1/2 IN.	3/8 IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPARENT	ABSORP. (PERCENT)	BULK	BULK SSD	APPARENT	ABSORP. (PERCENT)
76.2	65.1	56.8	41.2	31.9	25.7	20.6	14.5	9.5	6.3								
57.7	50.4	45.0	33.9	28.2	23.3	19.2	14.6	10.4	6.9								
78.6	69.3	60.9	42.9	34.1	27.5	22.7	16.7	12.0	8.9								
73.8	64.2	56.3	40.2	32.2	26.1	21.5	15.9	11.1	7.9								
52.6	42.3	34.5	23.7	18.5	14.7	11.5	7.7	4.6	2.7								
68.2	56.7	48.5	33.4	26.4	20.7	15.9	10.6	6.4	3.7								
52.2	42.8	37.5	28.2	22.8	18.7	15.7	12.6	9.4	6.5								
64.6	56.7	49.8	36.4	28.3	21.9	16.8	11.4	7.4	4.7								
64.6	54.0	46.8	33.1	24.1	18.6	14.6	9.9	6.0	3.6								
3.3	0.7	0.5	0.1							2.76	2.77	2.80	0.47				
98.4	58.7	36.3	1.8							2.69	2.71	2.75	0.89				
51	30	19	1														
			100	76.8	57.5	41.9	24.7	10.9	3.6					2.60	2.65	2.74	1.90

	FINENESS MODULUS (PERCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS) COARSE AGGREGATE MgSO4	COARSE AGGREGATE NaSO4	FINE AGGREGATE MgSO4	FINE AGGREGATE NaSO4	PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	AGGREGATE USE CLASSIFICATION
											RBIa,C
											RBIa,C
											RBIa,C
			28.3								
											RBIa,C
											RBIa,C
											RBIa,C
											RBIa,
											RBIa,
		102.4									
		106.4	26.1	1.63							
90	2.88					11.39					

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SUMMARY OF FIELD
TEST D
PINE VALL

12 JUN 81

TABL

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WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
		COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
		$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
									RBIa,CB
									RBIa,CB
									RBIa,CB
	28.3								
									RBIa,CA1
									RBIa,CA1
									RBIa,CA1
									RBIa,CA1
									RBIa,CA1
102.4									
106.4	26.1	1.63							
				11.39					

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MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

SUMMARY OF FIELD AND LABORATORY TEST DATA
PINE VALLEY, UTAH

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)			OVERBURDEN
							GRAVEL	SAND	FINES	
237	PI-A-37	Pine Valley, NE	Aaf	Sandy Gravel	GP-GM					
238	PI-A-38	Pine Valley, NE	Aaf	Sandy Gravel	GW-GM	Occ./ Many				
239	PI-A-39	Pine Valley, NE	Aaf	Sandy Gravel	GW-GM	Occ./ Many				
	PI-A-(37, 38,39)			Sandy Gravel	GP-GM					
240	PI-A-40	Pine Valley, NE	Aaf	Gravelly Sand	SP-SM	-/Few	20	70	10	
241	PI-A-41	Pine Valley, N	Aaf	Sandy Gravel	GW-GM	-/Few				
242	PI-A-42	Pine Valley, N	Aaf	Sandy Gravel	GM	-/Few				
243	PI-A-43	Pine Valley, N	Aaf	Sandy Gravel	GP-GM	-/Few				
	PI-A-(41, 42,43)			Sandy Gravel	GP-GM	-/Occ.				
244	PI-A-44	Pine Valley, N	Aaf	Sandy Gravel	GM	-/Few				
245	PI-A-45	Pine Valley, N	Aaf	Sandy Gravel	GM	-/Few				
246	PI-A-46	Pine Valley, N	Aaf	Sandy Gravel	GM	- / -				
	PI-A-(44, 45,46)			Gravelly Sand	GP-GM					

FIELD OBSERVATIONS						SIEVE ANALYSIS, AST						
OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.	½ IN.
1.0	13.0	Caliche/1-2/II	Slight				100	97.3	89.0	78.3	70.0	59.3
1.0	14.0	Caliche/1-2/II	Slight			97.6	94.2	92.1	89.2	83.6	76.9	65.3
1.0	14.0	Caliche/1-2/II	Slight			100	98.6	96.0	93.2	82.8	74.9	62.6
						94.7	94.7	91.7	85.3	76.0	67.1	56.0
6.0	13.0	Caliche/4-5/II	Slight									
1.0	13.0	Caliche/1-2/I,II	Slight			90.5	85.1	84.3	80.8	73.4	68.4	60.[illegible]
1.0	14.0	Caliche/7.5-8.5/II	Slight			100	96.3	92.0	90.0	85.9	81.7	73.[illegible]
1.0	14.0	Caliche/1-2,9-10/II	Slight			94.3	94.3	92.9	91.2	86.8	82.2	78.[illegible]
						95.0	95.0	92.6	91.1	85.7	79.[illegible]	70.[illegible]
1.0	3.0	Caliche/1-2,9-13/ II,III	Slight				100	97.2	97.2	91.5	88.4	83[illegible]
2.0	13.0	Caliche/7-13/II,III	Slight					100	98.0	94.9	91.8	83[illegible]
1.0	13.0	Caliche/1-2/II,III	Slight				100	98.6	97.5	95.0	91.5	84[illegible]
							100	97.9	97.9	95.7	93.0	87[illegible]

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LABORATORY TEST DATA

	IS, ASTM C 136 (PERCENT PASSING)									SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128								FINENE MODUL (PERCE
										COARSE AGGREGATE				FINE AGGREGATE				
										SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)	
	½ IN.	⅜ IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT		
	59.3	52.0	36.8	28.8	23.4	19.6	19.5	11.9	8.7									
	65.3	56.5	39.6	32.4	26.2	21.1	15.6	10.9	7.0									
	62.6	54.3	38.4	30.8	25.2	20.2	14.0	8.6	5.5									
	56.0	48.0	32.4	27.1	22.2	17.9	13.2	9.0	6.1									
4	60.4	54.2	39.5	28.3	18.4	13.6	10.7	8.5	6.5									
7	73.3	66.9	48.5	37.7	29.7	25.0	21.3	17.6	13.5									
2	78.6	67.2	50.1	38.3	26.5	19.9	15.6	12.3	9.4									
5	70.5	63.5	45.8	32.0	23.2	18.4	15.3	11.9	9.0									
4	83.6	75.6	51.8	41.1	31.6	25.5	21.7	18.0	14.2									
8	83.0	74.4	52.2	43.1	33.0	26.5	22.3	18.6	14.5									
5	84.1	76.1	54.6	39.6	27.6	21.5	17.9	15.1	12.4									
0	87.8	82.4	62.8	40.9	27.1	20.9	17.6	14.8	11.9									

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...NESS ...ULUS ...ENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
			$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
										RBIa,CB
										RBIa,CB
										RBIa,CB
		32.3								
										RBIb,CB
										RBIa,CB
										RBIa,CB
										RBIa,CB
		21.7								
										RBIa,CB
										RBIa,CB
										RBIa,CB
		23.0								

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MX SITING INVES...
DEPARTMENT OF TH...
BMO/AFRC...

SUMMARY OF FIELD AND LABOR...
TEST DATA
PINE VALLEY, UTAH

12 JUN 81 TABLE A-1

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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT) GRAVEL	SAND	FINES	OVERBURDEN
247	PI-FA-2	Pine Valley, N	Aol	Gravelly Sand	SP	-/Occ.				
				No.4-No.200						
248	PI-FA-3	Pine Valley, E	Aaf	Sandy Gravel	GP					
				No.4-No.200						
249	PI-R-2	Pine Valley, NE		1.5in-0.75in						
				0.75in-No.4						
				Blend (1.5in-No.4)						
250	PI-R-3	Pine Valley, E		1.5in-0.75in						
				0.75in-No.4						
				Blend (1.5in-No.4)						

FIELD OBSERVATIONS						SIEVE ANALYSIS, ASTM						
THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.	½ IN.
1.0	15.0	Caliche/ - /I	Slight					100	98.3	91.7	87.4	79.9
						100	98.4	97.1	91.6	82.5	71.4	58.7
				Very Hard	Fresh				100	62.4	3.5	0.7
										100	98.4	51.6
									100	81	51	26
				Hard	Slight to Moderate				100	61.2	6.0	0.5
										100	98.3	46.4
										100	81	52

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LABORATORY TEST DATA

	...M C 136 (PERCENT PASSING)								SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128								FINENESS MODULUS (PERCENT)
									COARSE AGGREGATE				FINE AGGREGATE				
									SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)	
	3/8 IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT		
[illegible]	74.2	61.0	47.7	34.8	24.0	10.1	3.0	1.2					2.52	2.59	2.70	2.6	27.9
		100	84.0	67.3	47.4	18.3	4.1	0.2									
7	47.1	35.3	27.6	15.4	9.9	5.2	3.1	2.4					2.61	2.65	2.72	1.48	
		100	81.9	47.8	26.9	13.3	6.1	1.7									
.7	0.4	0.2															
.6	30.0	2.3							2.84	2.87	2.91	0.76					
	15								2.86	2.87	2.88	0.24					
.5									2.62	2.63	2.65	0.51					
.4	27.0	4.9							2.60	2.62	2.65	0.75					
[illegible]	24	14	3														30.4

UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
		COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
		$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
				12.95					FA
				12.48					FA
									RBIa,CA1
103.3	20.1	0.19							
									RBIa,CA1
84.2									
96.2		0.91							

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SUMMARY OF FIELD AND LABORATORY TEST DATA
PINE VALLEY, UTAH

12 JUN 81 TABLE A-1

APPENDIX B

SUMMARY OF FIELD PETROGRAPHIC AND GRAIN-SIZE ANALYSES

FIELD PETROGRAPHIC AND GRAIN-SIZE ANALYSES

Field petrographic observations are presented in Table B-1. Field stations were established at various locations throughout the study area where detailed petrographic descriptions of potential basin-fill sources of aggregates were recorded. Detailed explanations for the column headings of Table B-1 are as follows:

COLUMN HEADING	EXPLANATION
MAP NUMBER	Map numbers are sequentially arranged identifiers of field petrographic stations occupied during the course of the aggregate study.
FIELD STATION	These designations are internal DARS identifiers of field petrographic designations.
LOCATION	The location column lists the geographic portion of the valley in which the field station is located (e.g., NE-northeast).
GEOLOGIC UNIT	The geologic unit listed is a term used to differentiate basin-fill deposits based on geomorphology. A geologic unit cross reference, outlining all units used, is included as Table F-3.
FIELD OBSERVATIONS	
Clast Count	Clast or petrographic counts are the main data collected during the field petrographic analysis. Data collected include lithology and percent present by size. Categorization by lithology is done to determine general percentages of nondeleterious and deleterious materials.
Other Deleterious Clasts Present	This column is reserved for recording additional types of materials present that are of poor quality for use as aggregate. Items mentioned include samples of rock types not sieved, counted, and described under clast count, such as: amorphous silica

(chert, opal, chalcedony), volcanic glass, mica, chlorite, friable materials, low density clasts (ash, vesicles, pumice, cinders), gypsum, pyrite, organic material, and coatings (clay and caliche).

Size Distribution	The estimated occurrence of boulders and cobbles is based on the appraisal of an entire deposit only if the materials are observed in the banks of prominent stream channels. Size distribution information for gravel was generally recorded only at trench locations. Any gravel values given are expressed as a percent of the total amount of less than 3.0-inch material present. The numeral zero is used to indicate a size fraction not observed, and the letter R is used to indicate the rare occurrence of a size fraction (one to four percent).
Gradation	Gradation information was recorded at trench locations only.
Maximum Particle Size	Maximum particle size is defined as the intermediate diameter length of the most frequently occurring clast present in a deposit (in centimeters). Erratic oversized materials (boulders, large cobbles) are generally not represented as the maximum particle size.
Particle Shape	Shape of clasts are classified into the following six categories.
Angular (ANG)	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Sub-angular (SA)	Particles are similar to angular but have somewhat rounded edges.
Sub-rounded (SR)	Particles exhibit nearly plane sides but have well-rounded corners and edges.
Rounded (R)	Particles have smoothly curved sides and no edges.
Platey (P)	Particles are thin and flat with either rounded or nonrounded corners and edges.
Elongate (E)	Particles are several times longer than they are wide with rounded corners and edges.

Remarks

This column is used to describe the general site location of petrographic field stations; location terms used include: surface, shallow wash, stream channel bank or bottom, borrow pit, and road cut. Surface indicates analysis was performed on top of the stated geologic unit. Shallow wash indicates analysis was performed on top of the unit but at the bottom of a small swale. Stream channel bank or bottom indicates analysis was performed in an exposed section (incision) or within a minor stream channel deposit, respectively.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, > 1 IN. TO ≤ 3 IN. DIAMETER (PER								
				NON-DELETERIOUS						DELETE		
				Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE	CHERT	TUF
301	PI-1	Pine Valley, E	Aaf		80	18		2				
302	PI-2	Pine Valley, E	Aaf	4	88	8						
303	PI-3	Pine Valley, E	Aaf	10	74	12		4				
304	PI-4	Pine Valley, E	Aaf		86	14						
305	PI-5	Pine Valley, E	Aaf	4	82	12						
306	PI-6	Pine Valley, E	Aaf		92	8						
307	PI-7	Pine Valley, E	Aaf	12	82	6						
308	PI-8	Pine Valley, E	Aaf	2	92	6						
309	PI-9	Pine Valley, E	Aaf	94	6							
310	PI-10	Pine Valley, E	Aaf	12	86			2				
311	PI-11	Pine Valley, E	Aaf	12	78	10						
312	PI-12	Pine Valley, E	Aaf	36	40	2		2	2	18		
313	PI-13	Pine Valley, E	Aaf	38	56	6						

FIELD OBSERVATIONS

(PERCENT)			CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)											OTHER DELETERIOUS CLASTS PRESENT	SIZE DIS
ETERIOUS			NON-DELETERIOUS						DELETERIOUS						PERCEN TOTA
TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALICHE	CHERT	TUFF	GLASS	OTHER		BOUL-DERS
			4	70	16		6		4					Caliche	R
			8	88	2				2					Caliche	
			16	76	8									Caliche	
				92	2				2				4	Caliche	
		2		94	6									Caliche	
				100										Caliche	
			8	82	8				2					Caliche	
				90	10									Caliche	
			64	36										Caliche	
			12	86	2									Caliche	
			4	78	18									Caliche, Chert	
			36	52				2	10					Caliche	
			24	52	6			4	14					Caliche	

OTHER DELETERIOUS [C]LASTS PRESENT	SIZE DISTRIBUTION PERCENT OF TOTAL BOUL-DERS	COB-BLES	< 3" % GRA-VEL	GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
Caliche	R	5	70		6	A	Road Cut
Caliche					4	A,SA	Shallow Wash
Caliche					25	A,SA	Stream Channel
Caliche					6	A,SA	Stream Channel,Bank
Caliche					8	A,SA	Stream Channel,Bank
Caliche					8	A,SA	Shallow Wash
Caliche					7	A,SA	Shallow Wash
Caliche					6	A,SA	Shallow Wash
Caliche					6	SA,SR	Shallow Wash
Caliche					6	A,SA	Stream Channel,Bottom
Caliche, Chert					9	A,SA	Shallow Wash
Caliche					15	A,SA	Stream Channel,Bank
Caliche					12	A,SA	Stream Channel,Bank

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SUMMARY OF FIELD PETROGRAPHIC AND GRAIN-SIZE ANALYSES PINE VALLEY, UTAH

12 JUN 81 TABLE B-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, $>$ 1 IN. TO $\leq$ 3 IN. DIAMETER (PI								
				NON-DELETERIOUS						DELET		
				Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE	CHERT	T
314	PI-14	Pine Valley, E	Aaf	100								
315	PI-15	Pine Valley, E	Aaf		70	24			2		4	
316	PI-16	Pine Valley, E	Aaf		94	6						
317	PI-17	Pine Valley, E	Aaf		96	4						
318	PI-18	Pine Valley, N	Aaf		90	10						
319	PI-19	Pine Valley, N	Aaf		96	4						
320	PI-20	Pine Valley, NE	Aaf		92	8						
321	PI-21	Pine Valley, NE	Aaf		78	22						
322	PI-22	Pine Valley, NE	Aaf		88	12						
323	PI-23	Pine Valley, NE	Aaf		84	16						
324	PI-24	Pine Valley, NE	Aaf		88	12						
325	PI-25	Pine Valley, NE	Aaf		88	12						
326	PI-26	Pine Valley, NE	Aaf		86	12						

FIELD OBSERVATIONS

(PERCENT)			CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)											OTHER DELETERIOUS CLASTS PRESENT	SIZE D
ETERIOUS			NON-DELETERIOUS						DELETERIOUS						PERCE TOT
TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALICHE	CHERT	TUFF	GLASS	OTHER		BOUL-DERS
			100												5
			2	80	18									Caliche, Chert	
			2	84	12				2					Caliche	
				98	2									Caliche	
				96	4									Caliche	
				94	6									Caliche	
				96	4									Caliche	
				62	38										
				86	14									Chert	
				86	14									Caliche	
				72	24		4							Caliche	R
				80	18					2				Caliche, Chert	5
		2		78	22									Caliche	R

2

OTHER ELETERIOUS STS PRESENT	SIZE DISTRIBUTION PERCENT OF TOTAL		< 3" %	GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
	BOULDERS	COBBLES	GRAVEL				
	5	20	6		20	A,SA	Stream Channel,Bank
iche, Chert					7	A,SA	Shallow Wash
iche					6	SA,SR	Shallow Wash
liche					10	SA,SR	Stream Channel,Bank
liche					8	SA,SR	Shallow Wash
liche					5	SA,SR	Stream Channel,Bank
liche					5	SA,SR	Stream Channel,Bank
					11	A,SA,SR	Stream Channel,Bank
hert					12	A,SA,SR	Shallow Wash
aliche					7	SA,SR	Shallow Wash
aliche	R	5	75		9	SA,SR	Stream Channel,Bank
aliche, Chert	5	5	70		15	A,SA,SR	Stream Channel
aliche	R	5	60		12	A,SA,SR	Shallow Wash

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SUMMARY OF FIELD PETROGRAPHIC
AND GRAIN-SIZE ANALYSES
PINE VALLEY, UTAH

12 JUN 81 TABLE B-1

3

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, > 1 IN. TO ≤ 3 IN. DIAMETER (P							
				NON-DELETERIOUS						DELE	
				Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE	CHERT
327	PI-27	Pine Valley, NE	Aaf		96	4					
328	PI-28	Pine Valley, NE	Aaf		76	18					6
329	PI-29	Pine Valley, NE	Aaf		88	12					
330	PI-30	Pine Valley, N	Aaf		26	74					
331	PI-31	Pine Valley, N	Aaf		8	92					
332	PI-32	Pine Valley, NW	Aaf	14	60	18		8			
333	PI-33	Pine Valley, NW	Aaf	18	20	6		40			6
334	PI-34	Pine Valley, NW	Aaf	2	2			84	10	2	
335	PI-35	Pine Valley, W	Aaf	70	6	6		4	8		
336	PI-36	Pine Valley, W	Aaf	56	2	24		8	10		
337	PI-37	Pine Valley, W	Aaf	10	42	36		4			6
338	PI-38	Pine Valley, W	Aaf	42	32	14		12			
339	PI-39	Pine Valley, W	Aaf	48	34	12			6		

FIELD OBSERVATIONS

ERCENT)			CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)											OTHER DELETERIOUS CLASTS PRESENT	SIZE DIS
ETERIOUS			NON-DELETERIOUS						DELETERIOUS						PERCEN TOTA
TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALICHE	CHERT	TUFF	GLASS	OTHER		BOUL-DERS
				92	6				2					Caliche	
				62	34					4				Caliche, Chert	
				72	22					6				Caliche, Chert	
				2	98									Caliche	
					100									Caliche	
			2	72	24		2							Caliche	
10			12	20	16		36			2				Caliche	0
							90	10						Caliche, Chalcedony	
6			40	2	42		8	6		2				Caliche	
			12	4	54		28	2						Caliche	
2			18	4	74		4							Caliche, Chert	
			48	12	18		22							Caliche, Chert	
			44	18	22		16							Caliche	

2

OTHER ELETERIOUS ASTS PRESENT	SIZE DISTRIBUTION			GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
	PERCENT OF TOTAL		< 3" %				
	BOUL-DERS	COB-BLES	GRA-VEL				
liche					15	A,SA	Surface
liche, Chert					18	A,SA,SR	Shallow Wash
liche, Chert					17	A,SA,SR	Shallow Wash
liche					9	A,SA,SR	Shallow Wash
liche					7	SA,SR	
liche					9	A,SA	Stream Channel,Bank
liche	0	R	40		6	A,SA	Stream Channel,Bank
liche, alcedony					5	A,SA	Stream Channel,Bank
liche					10	A,SA	Shallow Wash
liche					9	A,SA	Shallow Wash
liche, Chert					6	A,SA	Road Cut
liche, Chert				Well	8	A,SA	Shallow Wash
liche					6	A,SA	Shallow Wash

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SUMMARY OF FIELD PETROGRAPHIC
AND GRAIN-SIZE ANALYSES
PINE VALLEY, UTAH

12 JUN 81 TABLE B-1 PAGE 3 OF 4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, > 1 IN. TO ≤ 3 IN. DIAMETER (PE								
				NON-DELETERIOUS						DELET		
				Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE	CHERT	T
340	PI-40	Pine Valley, W	Aaf	96	2			2				
341	PI-41	Pine Valley, C	Aaf	76	24							
342	PI-42	Pine Valley, C	Aaf	56	2	2		40				
343	PI-43	Pine Valley, S	Aaf	84	12	4						
344	PI-44	Pine Valley, S	Aaf	66	24	10						
345	PI-45	Pine Valley, S	Aaf	22	18	52		6	2			
346	PI-46	Pine Valley, S	Aaf	4				92				

(PERCENT)			CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)												FIELD OBSERVATIONS	SIZE D
ETERIOUS			NON-DELETERIOUS						DELETERIOUS					OTHER DELETERIOUS CLASTS PRESENT	PERC TO
TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALICHE	CHERT	TUFF	GLASS	OTHER		BOUL-DERS
			98	2										Caliche	
			46	44	1				8					Caliche	
			60	2	10		28							Caliche	
			42	28	14			2		14				Caliche	5-10
			24	22	54									Caliche	
			6	6	78		6	2					2	Caliche	R
4			2				90				8			Caliche	R

2

OTHER DELETERIOUS CLASTS PRESENT	SIZE DISTRIBUTION PERCENT OF TOTAL BOULDERS	COBBLES	< 3" % GRAVEL	GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
Caliche					11	A,SA	Shallow Wash
Caliche					8	A,SA	Shallow Wash
Caliche					10	A,SA	Shallow Wash
Caliche	5-10	25	70		10	A,SA,SR	Road Cut
Caliche					12	A,SA,SR	Road Cut
Caliche	R	5	70		9	SA,SR	Borrow Pit
Caliche	R	R	55			A,SA	Road Cut

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SUMMARY OF FIELD PETROGRAPHIC
AND GRAIN-SIZE ANALYSES
PINE VALLEY, UTAH

12 JUN 81 TABLE B-1

APPENDIX C

TRENCH LOGS

EXPLANATION OF TRENCH LOGS

Trench logs were completed for excavated trenches. Each log presented in this appendix is chosen from a group of trench logs so that it represents the general aggregate conditions and properties of that entire group. Occasionally, the full compliment of trenches in a group was not excavated due to low gravel percentages and/or advanced caliche development found in the first one or two trenches of that group. Detailed explanations of the trench logs headings are as follows:

COLUMN HEADING		EXPLANATION
BULK SAMPLE		Representative samples were obtained by channel sampling a trench wall. Overburden and, in some trenches, dense caliche layers were avoided during the sampling procedure.
	II -	100 lb. sample (2 bags) for road-base aggregate testing.
	III -	400 lb. sample (55 gallon barrel) for concrete aggregate testing.
DEPTH		Depth corresponds to depth below ground surface in meters and feet.
LITHOLOGY		Graphic representation of soil types present in excavation.
USCS		Unified Soil Classification System symbols. For detailed information see Table F-1.
CONSISTENCY		The consistency of the in-situ deposit was estimated by visual observation of the soil in the trench walls, ease (or difficulty) of excavation of the trench, and trench-wall stability.

Consistency descriptions of coarse-grained soils (GW, GP, GM, GC, SW, SP, SM, SC) are as follows:

	DESCRIPTION
Very Loose (VL)	Will not hold vertical cut (when dry).

Loose (L) — Will hold vertical cut, but caves if disturbed.

Medium Dense (MD) — Holds vertical cut, even when disturbed; easily excavated.

Dense (D) — Holds vertical cut, difficult to excavate.

Very Dense (VD) — Very difficult to impossible to excavate.

SOIL DESCRIPTION

Except in cases where samples were classified based on laboratory data, the descriptions are based on visual classification. The procedures outlined in ASTM D 2487-69, Classification of Soils for Engineering Purposes and D 2488-69, Description of Soils (Visual-Manual Procedure) were followed. Solid lines across the column indicate known changes in the strata at the depth shown.

Definitions of some of the terms and criteria used to describe soils and conditions encountered during the excavation follow:

Descriptive Name — Name of soil, as determined by USCS, preceded by an adjective indicating the size range of the most abundant secondary material present.

Particle Size — For coarse-grained soils (sands and gravels) the size range of the particles visible to the unaided eye was estimated as fine, medium, coarse, or a combined range (e.g., fine to medium). These terms approximately correspond to the following sieve sizes:

Gravel	Fine	No. 4 to 3/4-inch sieve
	Coarse	3/4-inch to 3-inch sieve
Sand	Fine	No. 200 to No. 40 sieve
	Medium	No. 40 to No. 10 sieve
	Coarse	No. 10 to No. 4 sieve

Particle Shape — See Appendix B explanation pages.

Gradation — Gradations listed are those determined from percent amounts of boulders, cobbles, and gravel present. Descriptive terms used include: poor and well.

Poor(ly)	Predominantly one size or a range of sizes, with some intermediate sizes missing.
Well	Wide range in grain sizes present, with substantial amounts of most intermediate sizes.
Secondary Material	Percentage present by dry weight. Trace 5-12 percent Little 13-20 percent Some > 20 percent (e.g., Some slightly plastic silt)
Plasticity of Fines	See Appendix A explanation pages
HCL Reaction	As an aid for identifying calcium carbonate coatings and cementation, soil samples were tested in the field for their reaction to dilute hydrochloric acid. The intensity of the HCL reaction was described as none, weak, or strong.
Caliche	Caliche is a term applied to calcareous material of secondary accumulation. In this study, the definition includes both the soluble calcium (and other) salts and the clastic material (gravel, sand, silt or clay) in which the salts exist. See Table F-2 for a description of the stages of caliche development.
Cobbles and Boulders	See Appendix A explanation pages.
Lithology	The various rock types found in an excavated deposit are listed in order of decreasing abundance.
Remarks	This column was provided for comments regarding difficulty of excavation, caliche development, and backhoe refusal. Refusal indicates the inability of a JCB 3DIII backhoe (Case 680 equivalent) with a 2-foot wide bucket to excavate a trench to completion.
SIEVE ANALYSIS	The numbers cited represent the percentage by dry weight of each of the following soil components.

GR	Coarse aggregate particles that pass a 3-inch (75 mm) sieve but are predominantly retained on a No. 4 (4.75 mm) sieve.
SA	Fine aggregate particles that almost entirely pass a No. 4 sieve but are predominantly retained on a No. 200 (0.075 mm) sieve.
FI	Soil particles that pass a No. 200 sieve (silt and clay).

All percentages shown on logs are the result of laboratory testing.

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2	2, 4, 6, 8		SP	medium dense	GRAVELLY SAND, fine to medium, subrounded to rounded, poorly graded; some fine to coarse, rounded gravel; strong HCl reaction; trace stage I caliche; rare cobble; predominantly limestone/dolomite, trace quartzite, chert.		39	60	1
	3, 4	10, 12, 14		SP	medium dense	SAND, fine to medium, subrounded to rounded, poorly graded; trace fine, rounded gravel, strong HCl reaction; predominantly limestone/dolomite, little quartzite, trace chert.				
	5, 6	16, 18, 20				TOTAL DEPTH 15.0 ft. (4.6m)				

TRENCH DETAILS

SURFACE ELEVATION	: 5200 ft. (1585m)
DATE EXCAVATED	: 2 December 1980
SURFACE GEOLOGIC UNIT	: Aol
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: W-E

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TRENCH LOG OF PI-FA-2
PINE VALLEY, UTAH

12 JUN 81

FIGURE C-1

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0–2		SM	loose to medium dense	SILTY SAND, stage II caliche from 1' to 2' - OVERBURDEN				
X	1–4	2–13		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse subrounded sand; trace silt; strong HCl reaction; stage I - II caliche in scattered lenses; few cobbles and boulders; predominantly limestone/dolomite, trace quartzite and volcanics.		47	44	9
	4	13				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 5620 ft. (1713m)
DATE EXCAVATED : 21 November 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : N-S

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TRENCH LOG OF PI-A-1
PINE VALLEY, UTAH

12 JUN 81

FIGURE C-2

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0–2		SM	loose dense	SILTY SAND, stage III caliche from 1' to 2' - OVERBURDEN				
	1, 2, 3, 4	2–14		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; trace silt; strong HCl reaction; stage II caliche in scattered lenses; few cobbles; predominantly limestone/dolomite, little quartzite.		61	28	11
	5, 6	14–20				TOTAL DEPTH 14.0 ft. (4.3m)				

TRENCH DETAILS

SURFACE ELEVATION : 5760 ft. (1756m)

DATE EXCAVATED : 22 November 1980

SURFACE GEOLOGIC UNIT : Aafg

TRENCH LENGTH : 15 ft. (4.6m)

TRENCH ORIENTATION : W-E

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TRENCH LOG OF PI-A-4
PINE VALLEY, UTAH

12 JUN 81

FIGURE C-3

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
				GM	dense	SANDY GRAVEL, stage III caliche				
		2		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; trace slightly plastic silt; strong HCl reaction; thin layers of stage II caliche; some cobbles, rare boulder; predominantly limestone/dolomite, trace quartzite.		58	33	9
	4	13				TOTAL DEPTH 13.0 ft. (4.0 m)				

Depth scale — meters: 0, 1, 2, 3, 4, 5, 6; feet: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

TRENCH DETAILS

SURFACE ELEVATION : 6000 ft, (1829m)
DATE EXCAVATED : 22 November 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 15 ft, (4.6m)
TRENCH ORIENTATION : NE-SW

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TRENCH LOG OF PI-A-10
PINE VALLEY, UTAH

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FIGURE C-4

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2, 3, 4	2, 4, 6, 8, 10, 12		GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to medium, subrounded sand; little slightly plastic silt; strong HCl reaction; stage II caliche at 8' to 7' and 10' to 11'; few cobbles; limestone/dolomite; quartzite.	caliche layer; caliche layer	51	31	18
	5, 6	14, 16, 18, 20				TOTAL DEPTH 14.0 ft. (4.3m)				

TRENCH DETAILS

SURFACE ELEVATION : 5500 ft. (1676m)

DATE EXCAVATED : 22 November 1980

SURFACE GEOLOGIC UNIT : Aafg

TRENCH LENGTH : 15 ft. (4.6m)

TRENCH ORIENTATION : N-S

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TRENCH LOG OF PI-A-13
PINE VALLEY, UTAH

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FIGURE C-6

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1	2		SM	medium dense	GRAVELLY SAND, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded gravel; little silt; stage III caliche throughout.				
	2, 3, 4	4, 6, 8, 10, 12		SP-SM	medium dense	GRAVELLY SAND, fine to medium, subrounded, poorly graded; little fine to coarse, subrounded gravel; trace silt; strong HCl reaction; volcanics, limestone, quartzite.				
	5, 6	14, 16, 18, 20				TOTAL DEPTH 14.0 ft. (4.3m)				

TRENCH DETAILS

SURFACE ELEVATION	: 5680 ft. (1731m)
DATE EXCAVATED	: 23 November 1980
SURFACE GEOLOGIC UNIT	: Aafs
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: W-E

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TRENCH LOG OF PI-A-15
PINE VALLEY, UTAH

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FIGURE C-9

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
		2		GP-GM	dense	SANDY GRAVEL, stage III caliche throughout.				
	1 – 4	4 – 12		GW-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, well graded; some fine to coarse, subrounded sand; trace silt; strong HCl reaction; some cobbles and boulders; limestone, quartzite, volcanics.		63	32	5
	4 – 6	14 – 20				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 6200 ft. (1890m)
DATE EXCAVATED : 23 November 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 14 ft. (4.3m)
TRENCH ORIENTATION : NE-SW

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TRENCH LOG OF PI-A-17
PINE VALLEY, UTAH

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FIGURE C-7

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
		2		GM	very dense	SANDY GRAVEL, stage III caliche throughout.	difficult excavatability			
	1, 2, 3	4, 6, 8, 10, 12		GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; little slightly plastic silt; strong HCl reaction; some stage II caliche; some cobbles, few boulders; quartzite, limestone, volcanics.		53	30	17
	4, 5, 6	14, 16, 18, 20				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 6010 ft. (1832m)
DATE EXCAVATED : 23 November 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 14 ft. (4.3m)
TRENCH ORIENTATION : W-E

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TRENCH LOG OF PI-A-21
PINE VALLEY, UTAH

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FIGURE C-9

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SIEVE ANALYSIS SA	SIEVE ANALYSIS FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
		2		SM	medium dense	SILTY SAND, stage II caliche - OVERBURDEN				
	1, 2, 3	4, 6, 8, 10, 12		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded, sand; trace silt; weak HCl reaction; few cobbles; volcanics, quartzite, limestone/dolomite.		49	46	5
	4, 5, 6	14, 16, 18, 20				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 6336 ft. (1931m)
DATE EXCAVATED : 24 November 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : NW - SE

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TRENCH LOG OF PI-A-24
PINE VALLEY, UTAH

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FIGURE C-9

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
				GP-GM	dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine, subrounded sand; trace slightly plastic silt; strong HCl reaction; stage II caliche from 1' to 2'; few cobbles and boulders; predominantly limestone/dolomite, trace quartzite, volcanics.	caliche	59	34	7
						TOTAL DEPTH 13.5 ft. (4.1m)				

Depth scale: meters 0, 1, 2, 3, 4, 5, 6; feet 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

TRENCH DETAILS

SURFACE ELEVATION : 5530 ft. (1686m)
DATE EXCAVATED : 24 November 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : E-W

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TRENCH LOG OF PI-A-27
PINE VALLEY, UTAH

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BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2, 3	2, 4, 6, 8, 10		GW-GM	dense; very dense	SANDY GRAVEL, fine to coarse, subrounded, well graded; some fine to coarse, subrounded sand; trace slightly plastic silt; strong HCl reaction; stage II caliche from 1' to 3', stage III caliche at 11'; some cobbles; predominantly limestone/dolomite, trace quartzite.	caliche; refusal	62	30	8
	4, 5, 6	12, 14, 16, 18, 20				TOTAL DEPTH 11.0 ft. (3.3m)				

TRENCH DETAILS

SURFACE ELEVATION : 5320 ft. (1622m)

DATE EXCAVATED : 25 November 1980

SURFACE GEOLOGIC UNIT : Aafg

TRENCH LENGTH : 15 ft. (4.6m)

TRENCH ORIENTATION : N-S

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TRENCH LOG OF PI-A-30
PINE VALLEY, UTAH

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FIGURE C-11

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2, 3	2, 4, 6, 8, 10, 12		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; trace silt; strong HCl reaction; stage II caliche from 1' to 2' and in scattered lenses; some cobbles and boulders; predominantly limestone/dolomite, trace quartzite.	caliche	67	26	7
	4, 5, 6	14, 16, 18, 20				TOTAL DEPTH 12.5 ft. (3.8m)				

TRENCH DETAILS

SURFACE ELEVATION	: 5395 ft. (1644m)
DATE EXCAVATED	: 2 December 1980
SURFACE GEOLOGIC UNIT	: Aafg
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: N-S

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TRENCH LOG OF PI-A-34
PINE VALLEY, UTAH

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FIGURE C-12

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2, 3, 4	2, 4, 6, 8, 10, 12		GW-GM	dense	SANDY GRAVEL, fine to coarse, subrounded, well graded; some fine to coarse subrounded sand; trace slightly plastic silt; strong HCl reaction; trace stage II caliche; some cobbbles; rare boulder; predominantly limestone/dolomite, trace quartzite, chert.		62	32	6
		14				TOTAL DEPTH 14.0 ft. (4.3m)				
	5, 6	16, 18, 20								

TRENCH DETAILS

SURFACE ELEVATION	: 5535 ft. (1687m)
DATE EXCAVATED	: 2 December 1980
SURFACE GEOLOGIC UNIT	: Aafg
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: N-S

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TRENCH LOG OF PI-A-39
PINE VALLEY, UTAH

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FIGURE C-13

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0–1.8	0–6		SM	loose (0–4); medium dense (4–5); loose (5–6)	SILTY SAND, fine to medium, subrounded, poorly graded; some slightly plastic silt; little fine to coarse, subrounded gravel; strong HCl reaction; stage II caliche from 4' to 5'; rare cobble and boulder; predominantly limestone/dolomite, trace quartzite.	caliche (4–5)			
	1.8–4	6–13		SP-SM	medium dense	GRAVELLY SAND, fine to medium, subrounded, poorly graded; some fine to coarse, subrounded gravel; trace silt; strong HCl reaction; occasional cobble; predominantly limestone/dolomite.				
						TOTAL DEPTH 13.0 ft. (4.0m)				

Depth scale: METERS 0, 1, 2, 3, 4, 5, 6; FEET 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

TRENCH DETAILS

SURFACE ELEVATION	: 5620 ft. (1713m)
DATE EXCAVATED	: 2 December 1980
SURFACE GEOLOGIC UNIT	: Aafg
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: N-S

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TRENCH LOG OF PI-A-40
PINE VALLEY, UTAH

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FIGURE C-14

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	GRAVELLY SAND, silty - OVERBURDEN				
	1, 2, 3, 4	2, 4, 6, 8, 10, 12		GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to medium, subrounded sand; little slightly plastic silt; strong HCl reaction; little stage III caliche; few cobbles; predominantly dolomite.		51	35	14
		14				TOTAL DEPTH 14.0 ft. (4.3m)				
	5, 6	16, 18, 20								

TRENCH DETAILS

SURFACE ELEVATION : 5610 ft. (1710m)
DATE EXCAVATED : 3 December 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : W-E

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TRENCH LOG OF PI-A-42
PINE VALLEY, UTAH

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FIGURE C-15

E-TR-47-PI

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2, 3, 4	2, 4, 6, 8, 10, 12		GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse subrounded sand; little slightly plastic silt; strong HCl reaction; stage II caliche from 9' to 13' and in scattered lenses; rare cobble; predominantly limestone/dolomite.		48	38	14
					dense		caliche			
	5, 6	14, 16, 18, 20				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 5870 ft. (1789m)
DATE EXCAVATED : 3 December 1980
SURFACE GEOLOGIC UNIT : Aafg
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : N-S

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TRENCH LOG OF PI-A-44
PINE VALLEY, UTAH

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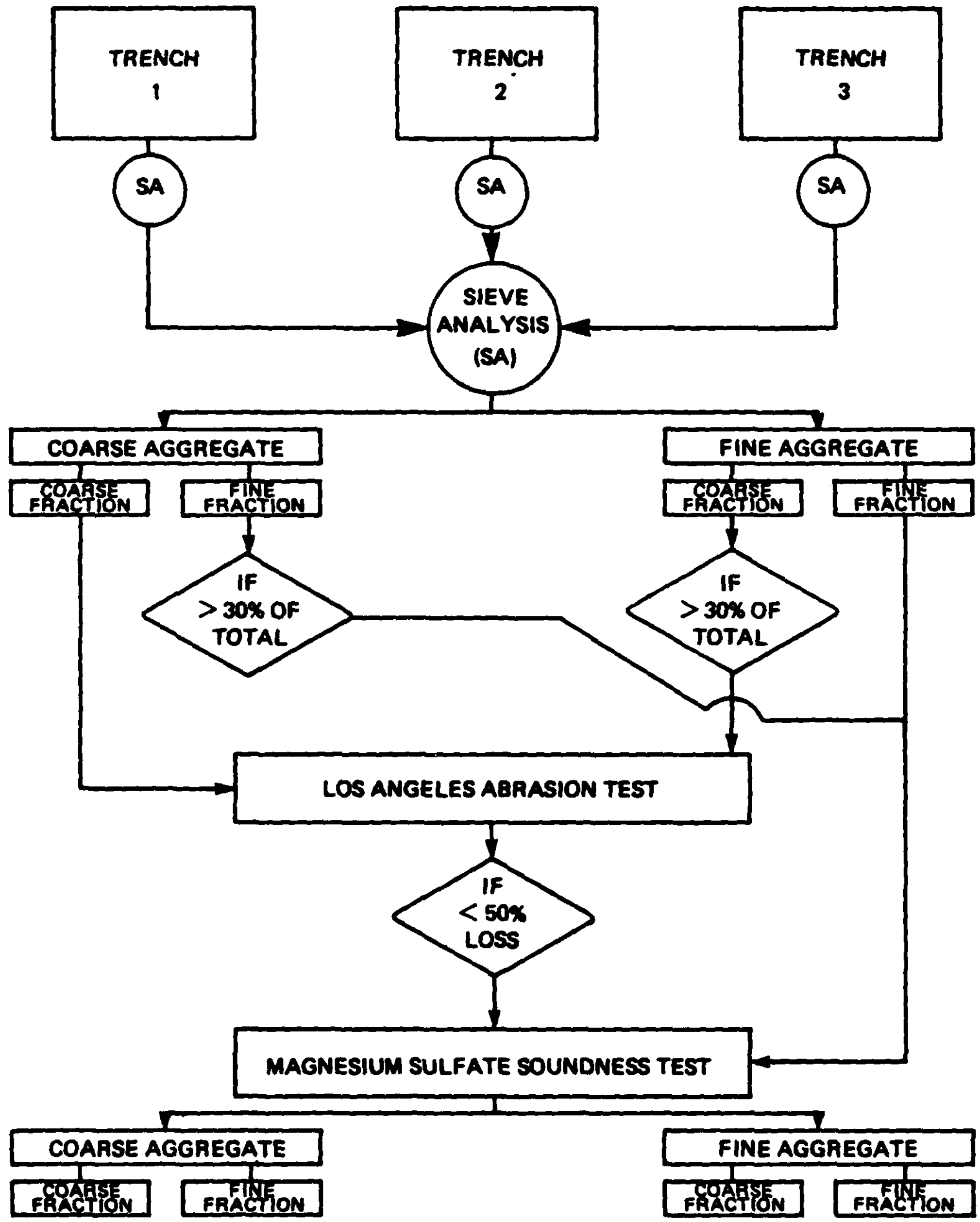
FIGURE C-16

APPENDIX D

FLOW DIAGRAM - ROAD-BASE AGGREGATES TESTING

FLOW DIAGRAM - CONCRETE TRIAL MIX DESIGN AND TESTING



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FLOW DIAGRAM — ROAD-BASE AGGREGATES TESTING

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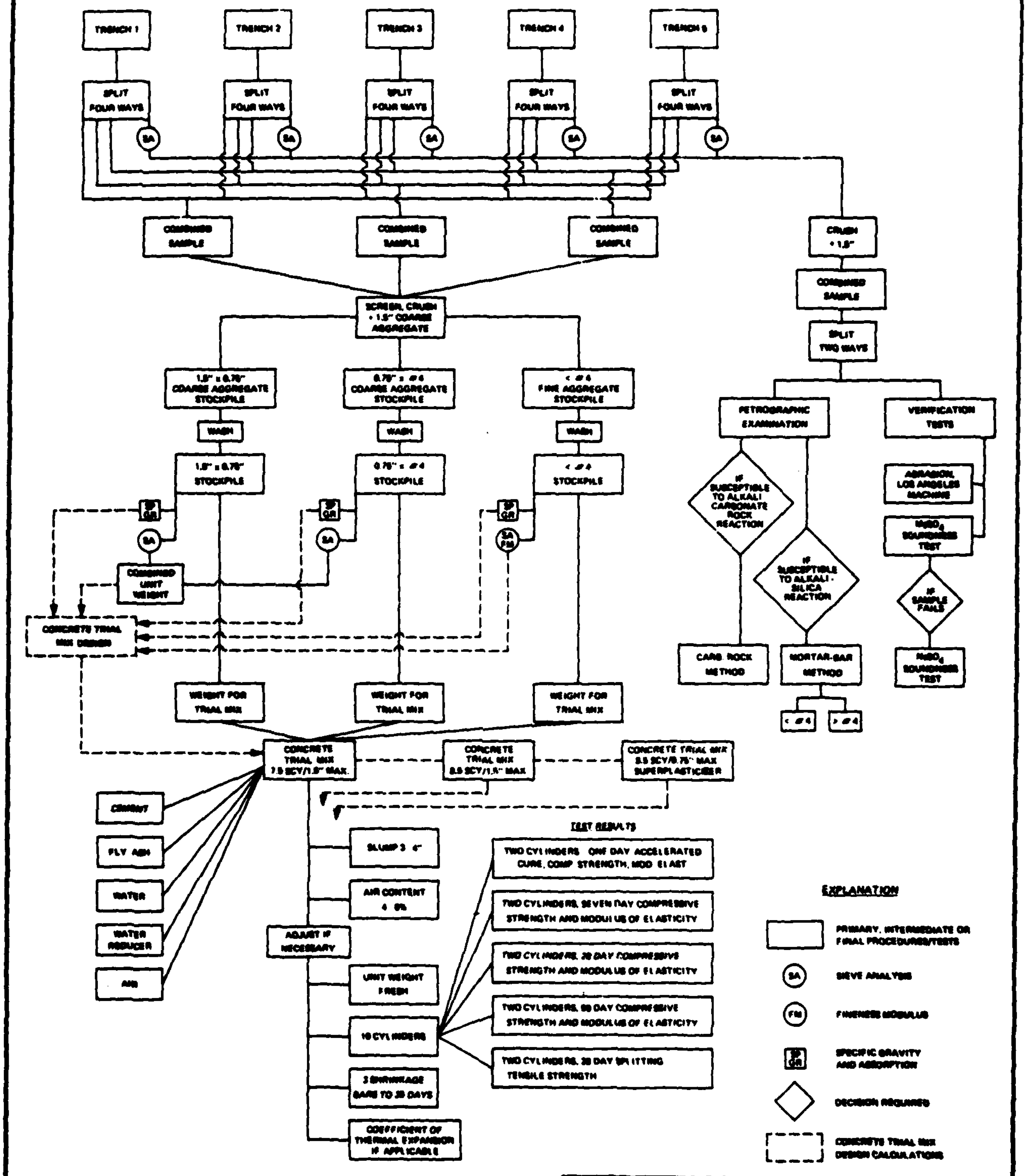
FIGURE D-1



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FLOW DIAGRAM – CONCRETE
TRIAL MIX DESIGN AND TESTING

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FIGURE D-2

APPENDIX E

CHEMICAL ANALYSES OF CEMENT,
FLY ASH, AND WATER USED IN
CONCRETE TRIAL MIXES

	PROPERTY ANALYZED	TOTAL PERCENTAGE OF SAMPLE	MINIMUM OR MAXIMUM REQUIREMENTS
CEMENT ASTM C 150, TYPE II	SiO_2	26.8	20.0 MIN.
	AL_2O_3	1.95	6.0 MAX.
	Fe_2O_3	2.71	6.0 MAX.
	MgO	1.57	6.0 MAX.
	ALKALIES (Na_2O + 0.658 K_2O)	0.53	0.60 MAX.
	LOSS ON IGNITION	0.56	3.0 MAX.
	SO_3	1.97	3.0 MAX.
	INSOLUBLE RESIDUE	0.61	0.75 MAX.
FLY ASH ASTM C 618, CLASS F	SiO_2	67.7	–
	AL_2O_2	17.2	–
	Fe_2O_3	8.34	–
	TOTAL	93.24	70.0 MIN.
	MgO	1.69	5.0 MAX.
	SO_3	0.14	5.0 MAX.
	Na_2O (OPTIONAL)	1.68	1.5 MAX.
	MOISTURE	0.08	3.0 MAX.
	LOSS ON IGNITION	0.63	12.0 MAX.
WATER CALIF. DEPT. TRANS. SEC. 90 - 2.03	pH	7.5	–
	COLOR	0 - 5	–
	SO_4	8 ppm	1300 ppm
	Cl	10.6 ppm	650 ppm
	OIL AND GREASE	NONE	NONE

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CHEMICAL ANALYSES OF CEMENT, FLY ASH, AND WATER USED IN CONCRETE TRIAL MIXES

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TABLE E-1

APPENDIX F

UNIFIED SOIL CLASSIFICATION SYSTEM

SUMMARY OF CALICHE DEVELOPMENT

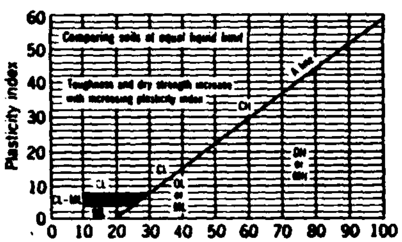
ERTEC WESTERN GEOLOGIC UNIT CROSS REFERENCE

Ertec

Major Division	Subdivision	Fines	Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)	Group Symbols[b]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria	
Coarse-grained soils: More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*	
		Gravels with fines (Appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics	Atterberg limits below "A" line, or *PI* less than 4	Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7	
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size	Clean sands (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*	
		Sands with fines (Appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5	Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7	

Use grain size curve in identifying the fractions as given under field identification

Major Division	Subdivision	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Fine-grained soils: More than half of material is *smaller* than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size						
	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.
[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):
After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.
Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):
After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):
After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.
After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.
Highly organic clays have a very weak and spongy feel at the plastic limit.

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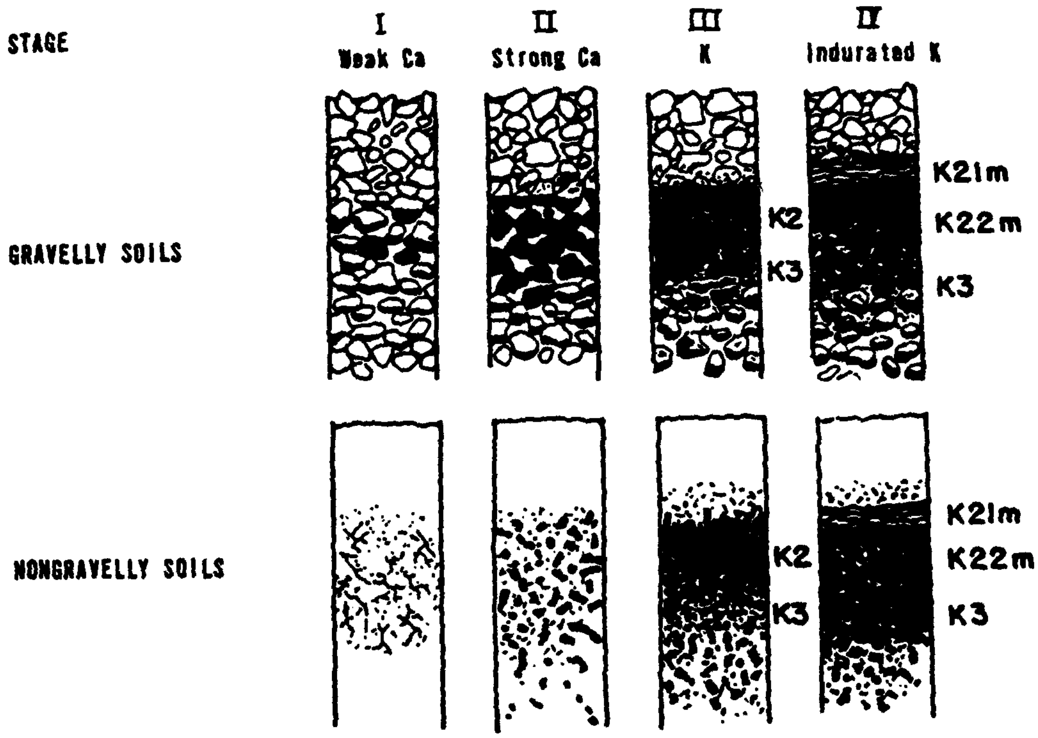
UNIFIED SOIL CLASSIFICATION SYSTEM

12 JUN 81

FIGURE F-1

DIAGNOSTIC CARBONATE MORPHOLOGY

STAGE	GRAVELLY SOILS	NONGRAVELLY SOILS
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings
II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Laminar horizon overlying plugged horizon



Stages of development of a caliche profile with time. Stage I represents incipient carbonate accumulation, followed by continuous build-up of carbonate until, in Stage IV, the soil is completely plugged.

Reference: Gile, L.G. Peterson, F.F., and Grossman, R.B., 1966, *The K horizon: A master horizon of carbonate accumulation*: Soil Science, v. 99, p. 74-82.

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SUMMARY OF CALICHE DEVELOPMENT

12 JUN 81

FIGURE F-2

UARSA POTENTIAL AGGREGATE SOURCE SYMBOLS	ERTEC WESTERN GENERAL GEOLOGIC UNIT EXPLANATION	
		ROCK
		Shown in regions where rock is exposed; the areally predominant (greater than 70 percent) rock type is indicated. In those areas where two rock types occur the predominant rock type is shown followed by the subordinate rock type (e.g. S_{1/I_1}, I_{4/S_1}). Rock may be subdivided into bedrock (R).
	I	IGNEOUS (UNDIFFERENTIATED) Rocks formed by solidification of a molten or partially molten mass
GR	I_1	Intrusive. Plutonic rocks formed by solidification of molten material beneath the surface (e.g. granite, granodiorite, diorite, gabbro)
Vu	I_2	Extrusive (intermediate and acidic). Volcanic rocks of intermediate and acidic composition formed by solidification of molten material at or near the surface (e.g. rhyolite, latite, dacite, andesite)
Vb	I_3	Extrusive (basic). Volcanic rocks of basic composition, generally formed by solidification of molten materials at or near the surface (e.g. basalt)
Vu	I_4	Extrusive (pyroclastic). Rocks formed by accumulation of volcanic ejecta (e.g. ash, tuff, welded tuff, agglomerate)
Su	S	SEDIMENTARY (UNDIFFERENTIATED) Rocks formed by accumulation of clastic solids, organic solids and or chemically precipitated minerals
Su, Qtz	S_1	Arenaceous and or Siliceous Rocks. Composed of sand size particles (e.g. sandstone, orthoquartzite) or of cryptocrystalline silica (e.g. opal, chert)
Ls, Do, Cau	S_2	Carbonate Rocks. Composed predominantly of calcium carbonate detritus or chemical precipitates (e.g. limestone, dolomite, chalk)
	S_3	Argillaceous Rocks. Composed of clay and silt-sized particles (e.g. siltstone, shale, claystone)
	S_4	Evaporite Rocks. Precipitated from solution as a result of evaporation (e.g. halite, gypsum, anhydrite, sylvite)
Su	S_5	Coarse Clastic Rocks. Composed of gravel-sized or larger clasts (e.g. conglomerate, breccia)
Mu	M	METAMORPHIC (UNDIFFERENTIATED) Rocks formed through recrystallization in the solid state of preexisting rocks by heat and pressure
Mu	M_1	Coarse grained rocks formed by higher-grade regional metamorphism, either banded or granular (e.g. gneiss, granulite, amphibolite)
Mu	M_2	Fine grained schistose rocks formed by lower grade regional metamorphism, e.g. schist, slate, phyllite
Mu	M_3	Nonfoliated rocks formed chiefly by contact metamorphism, e.g. hornfels, marble
Qtz	M_4	Metaquartzite, rocks formed by metamorphism of highly siliceous rocks
		BASIN-FILL
	A	BASIN-FILL DEPOSITS. Fine- to coarse-grained materials deposited principally by wind, water or gravity
Aal	A_1	Younger Fluvial Deposits. Major modern stream channel and flood-plain deposits
Au, Aal	A_2	Older Fluvial Deposits. Older incised stream channel and flood-plain deposits in elevated terraces bordering major modern drainages
Au	A_3	Eolian Deposits. Wind-blown deposits of sand occurring as either thin sheets (A_{3s}) or dunes (A_{3d})
Aol	A_4	Playa and Lacustrine Deposits. Deposits occurring in modern active playas (A_4) or in either inactive playas or older lake beds and abandoned shorelines associated with extinct lakes (A_{4o}).
Aaf	A_5	Alluvial Fan Deposits. Alluvial deposits consisting of debris flow and water-laid alluvium near mountain fronts, grading into predominantly water-laid alluvium deposited in shifting distributary channels near the basin center. Younger (A_{5y}), intermediate (A_{5i}) and older (A_{5o}) alluvial fans are differentiated by surface soil development, terrain conditions and present depositional erosional environment
Au	A_3/A_5	Mixed non-rock units. Most areally extensive unit is listed first
Aaf	A_{5y} (A_{5i})	Parenthetic unit underlies thin veneer of overlying mapped unit

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ERTEC WESTERN GEOLOGIC UNIT CROSS REFERENCE

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FIGURE F-3

APPENDIX G

CROSS REFERENCE FROM MAP NUMBER TO VERIFICATION ACTIVITY

CROSS REFERENCE FROM MAP NUMBER TO VERIFICATION ACTIVITY

Included in this appendix is one table that is presented to allow cross reference to be made from this aggregate resources study to an appropriate verification study. Map numbers in the number series 400 to 599 on Drawing 1 are keyed to the published Verification report of Pine Valley, Utah (FN-TR-27-PI-I and II). If detailed information is required from a verification activity, the following search procedure can be used: determine the location of the activity required on Drawing 1, note the map number, refer to that map number in Table G-1, read from that table the verification activity type and number, refer to the appropriate verification report for the data required.

MAP NUMBER	ACTIVITY LOCATION	MAP NUMBER	ACTIVITY LOCATION
401	GS - 2	423	T - 13
402	CS - 2	424	P - 19
403	CS - 4	425	CS - 25
404	GS - 7	426	P - 18
405	GS - 4	427	P - 3
406	GS - 5	428	GS - 38
407	T - 2	429	CS - 70
408	CS - 12	430	T - 1
409	GS - 18	431	CS - 72
410	GS - 17	432	GS - 26
411	GS - 16	433	GS - 25
412	CS - 9	434	GS - 27
413	T - 3	435	GS - 29
414	GS - 15	436	GS - 32
415	CS - 7	437	P - 10
416	T - 4	438	CS - 65
417	T - 14	439	P - 9
418	GS - 24	440	GS - 82
419	P - 20	441	GS - 43
420	CS - 79	442	CS - 57
421	CS - 80	443	GS - 57
422	CS - 82	444	GS - 58

T - TRENCH
B - BORING
P - TEST PIT
CS - SURFACE SAMPLE
GS - GEOLOGIC STATION

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DEPARTMENT OF THE AIR FORCE
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CROSS REFERENCE FROM MAP NUMBER
TO VERIFICATION ACTIVITY
PINE VALLEY, UTAH

12 JUN 81

TABLE 1 OF 3

MAP NUMBER	ACTIVITY LOCATION	MAP NUMBER	ACTIVITY LOCATION
445	GS - 61	467	CS - 40
446	GS - 52	468	T - 17
447	GS - 56	469	B - 4
448	P - 17	470	P - 24
449	CS - 17	471	CS - 44
450	T - 11	472	P - 25
451	GS - 70	473	T - 15
452	GS - 69	474	P - 21
453	CS - 20	475	CS - 28
454	GS - 77	476	T - 16
455	GS - 49	477	CS - 33
456	T - 7	478	P - 23
457	CS - 53	479	P - 22
458	T - 8	480	GS - 78
459	GS - 52	481	CS - 35
460	GS - 54	482	T - 18
461	P - 15	483	GS - 76
462	B - 8	484	GS - 74
463	P - 16	485	GS - 85
464	CS - 24	486	CS - 37
465	T - 10	487	T - 19
466	CS - 26	488	CS - 39

T TRENCH
B BORING
P TEST PIT
CS SURFACE SAMPLE
GS GEOLOGIC STATION

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DEPARTMENT OF THE AIR FORCE
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CROSS REFERENCE FROM MAP NUMBER
TO VERIFICATION ACTIVITY
PINE VALLEY, UTAH

12 JUN 81

TABLE 2 OF 3

MAP NUMBER	ACTIVITY LOCATION	MAP NUMBER	ACTIVITY LOCATION
489	GS - 73		
490	GS - 71		
491	GS - 34		
492	GS - 35		
493	GS - 47		
494	P - 14		
495	CS - 31		

T - TRENCH
B - BORING
P - TEST PIT
CS - SURFACE SAMPLE
GS - GEOLOGIC STATION

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DEPARTMENT OF THE AIR FORCE
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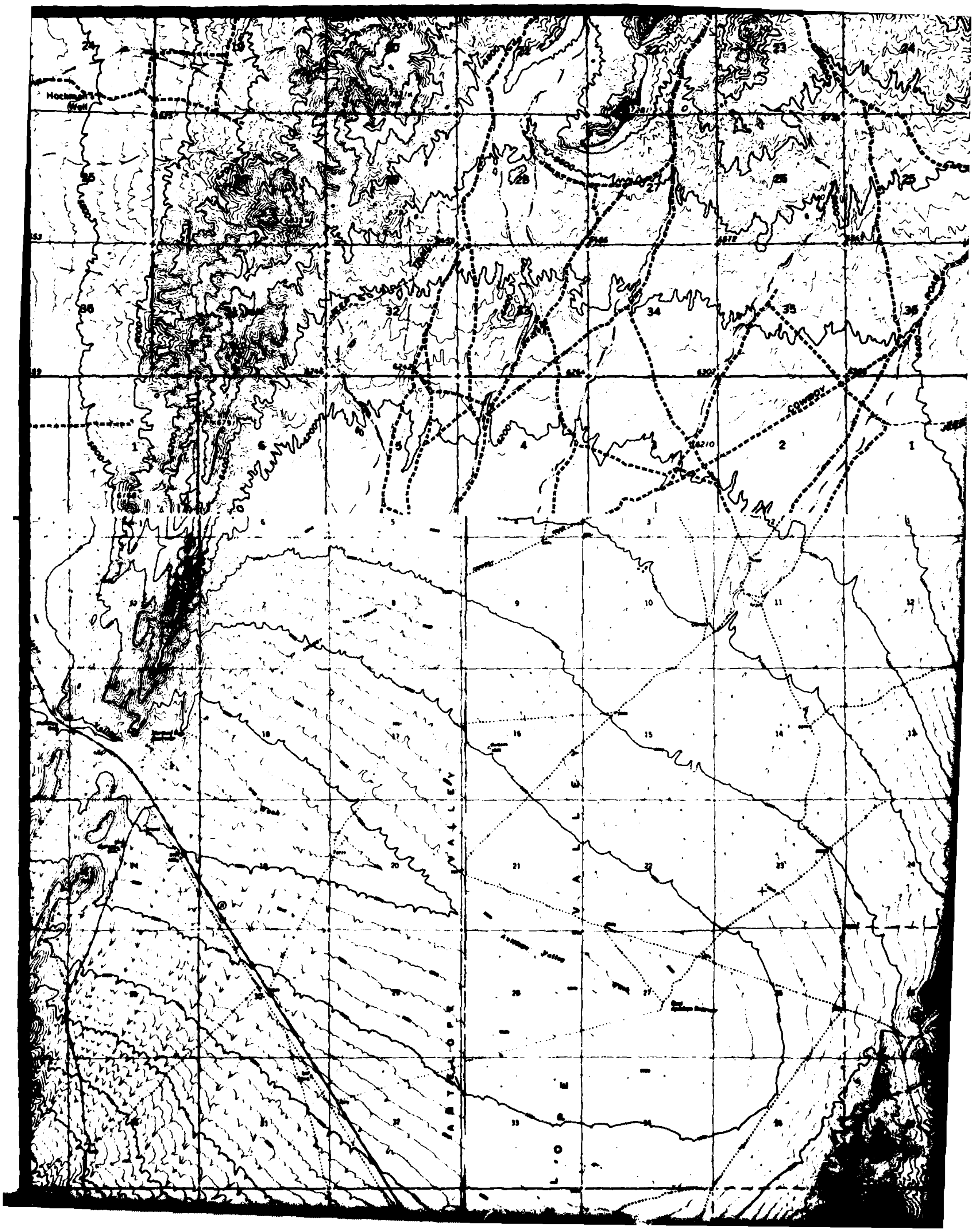
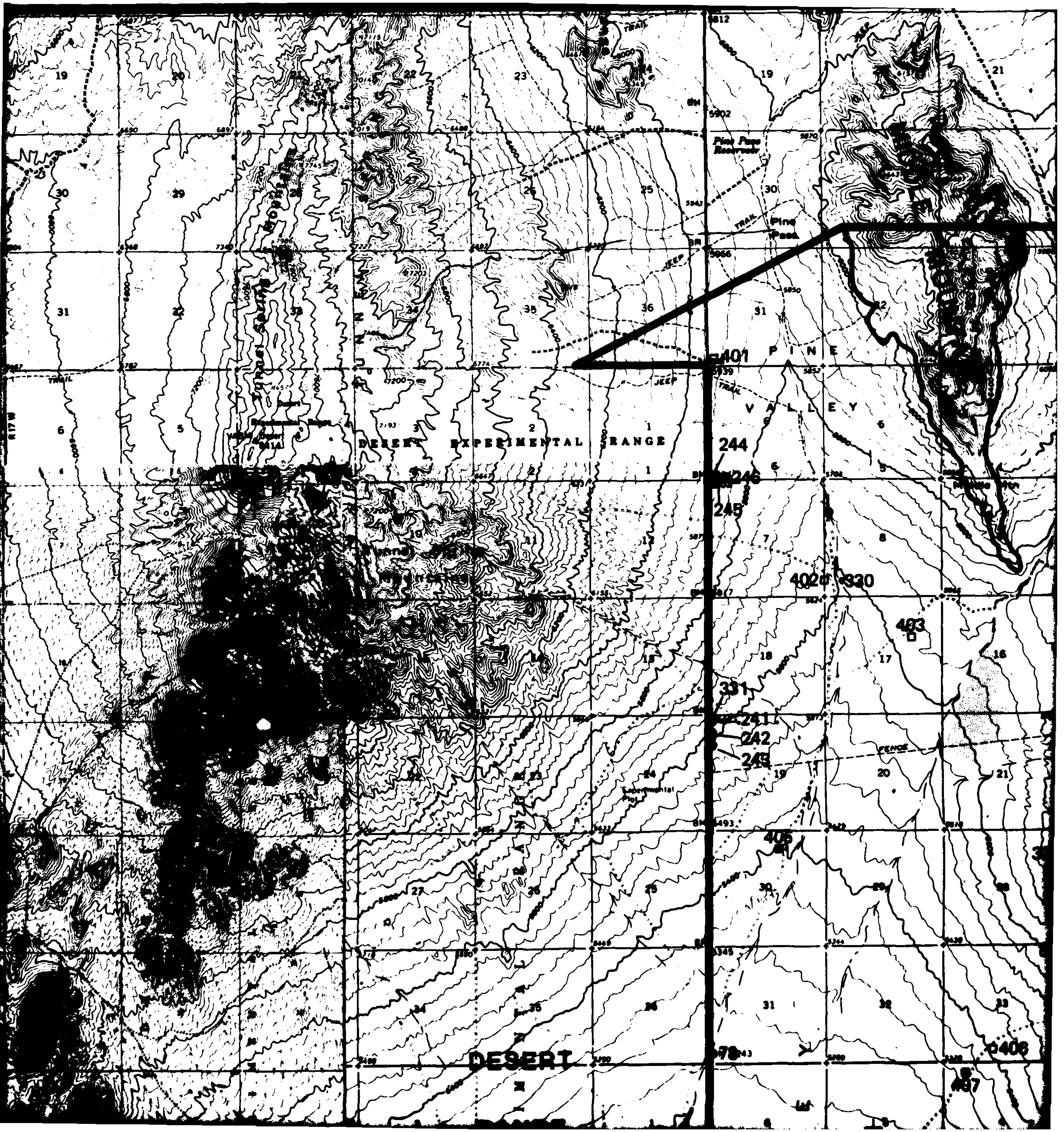
CROSS REFERENCE FROM MAP NUMBER
TO VERIFICATION ACTIVITY
PINE VALLEY, UTAH

12 JUN 81

TABLE 3 OF 3


Hackman's Well
COWBOY


PINE
VALLEY
DESERT EXPERIMENTAL RANGE
DESERT
Pine Pass Reservoir
Pine Pass
TRAIL
JEEP
FENCE
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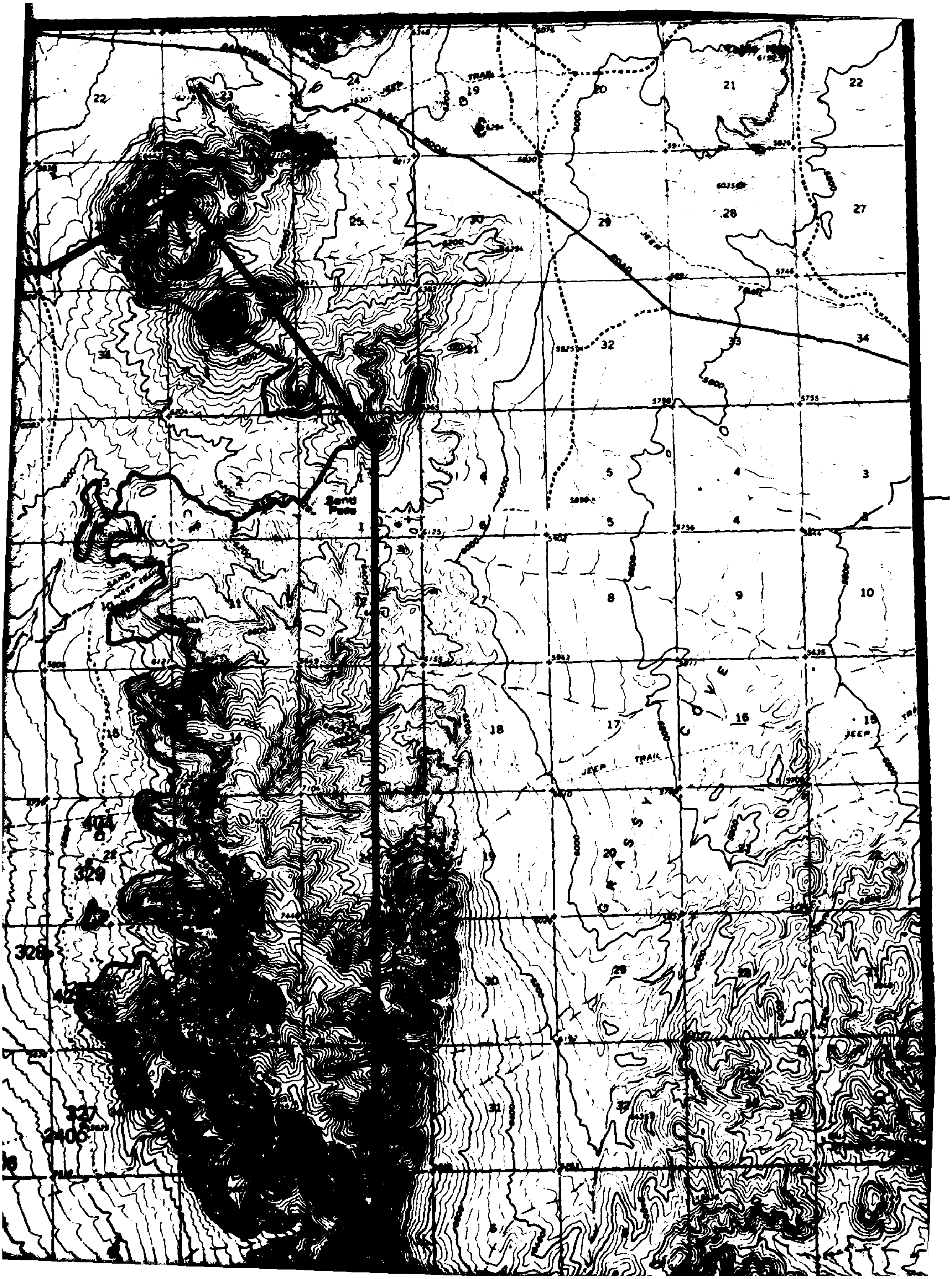
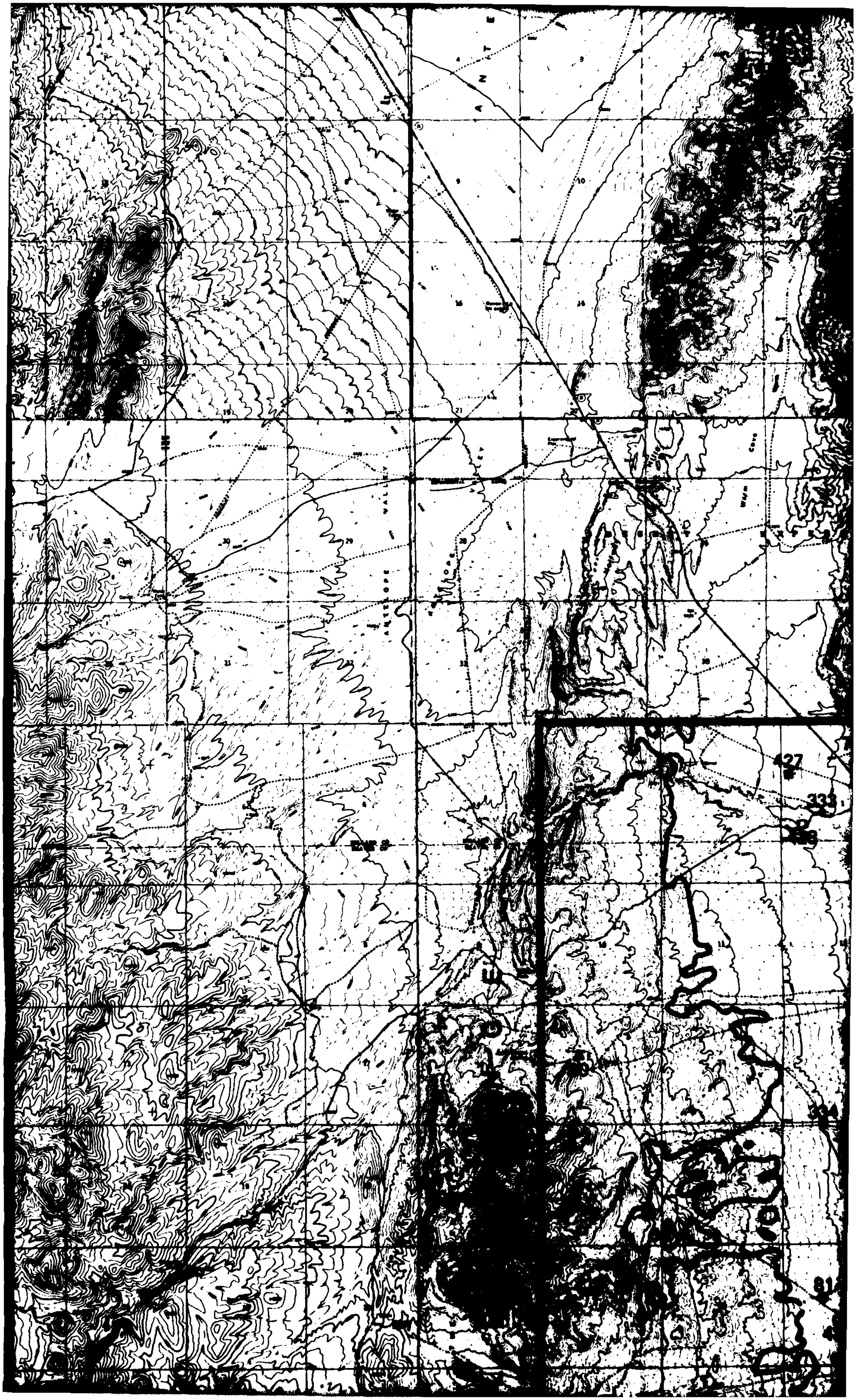
407



JEEP TRAIL
JEEP ROAD
Sand Pass
JEEP TRAIL
JEEP
TRAIL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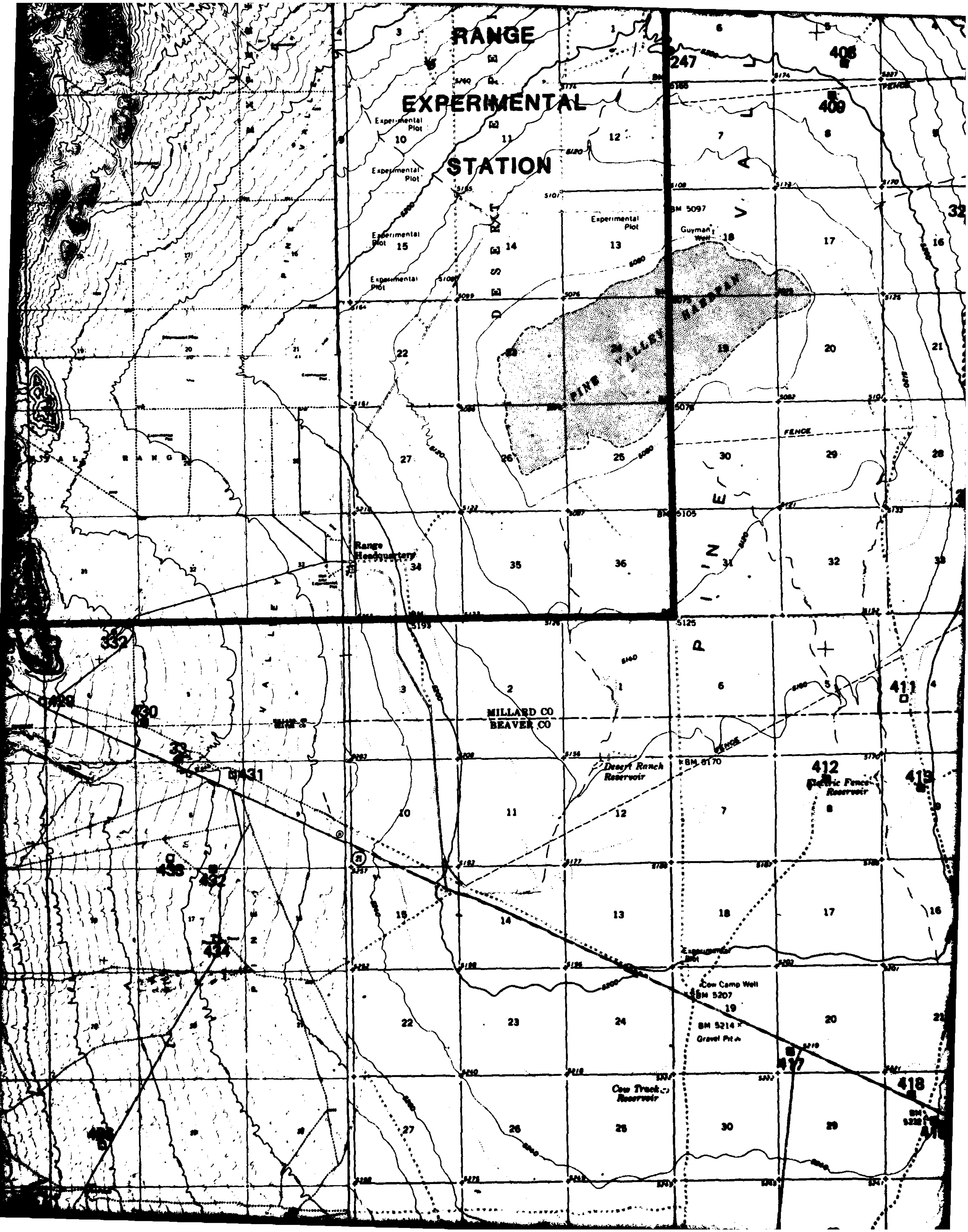
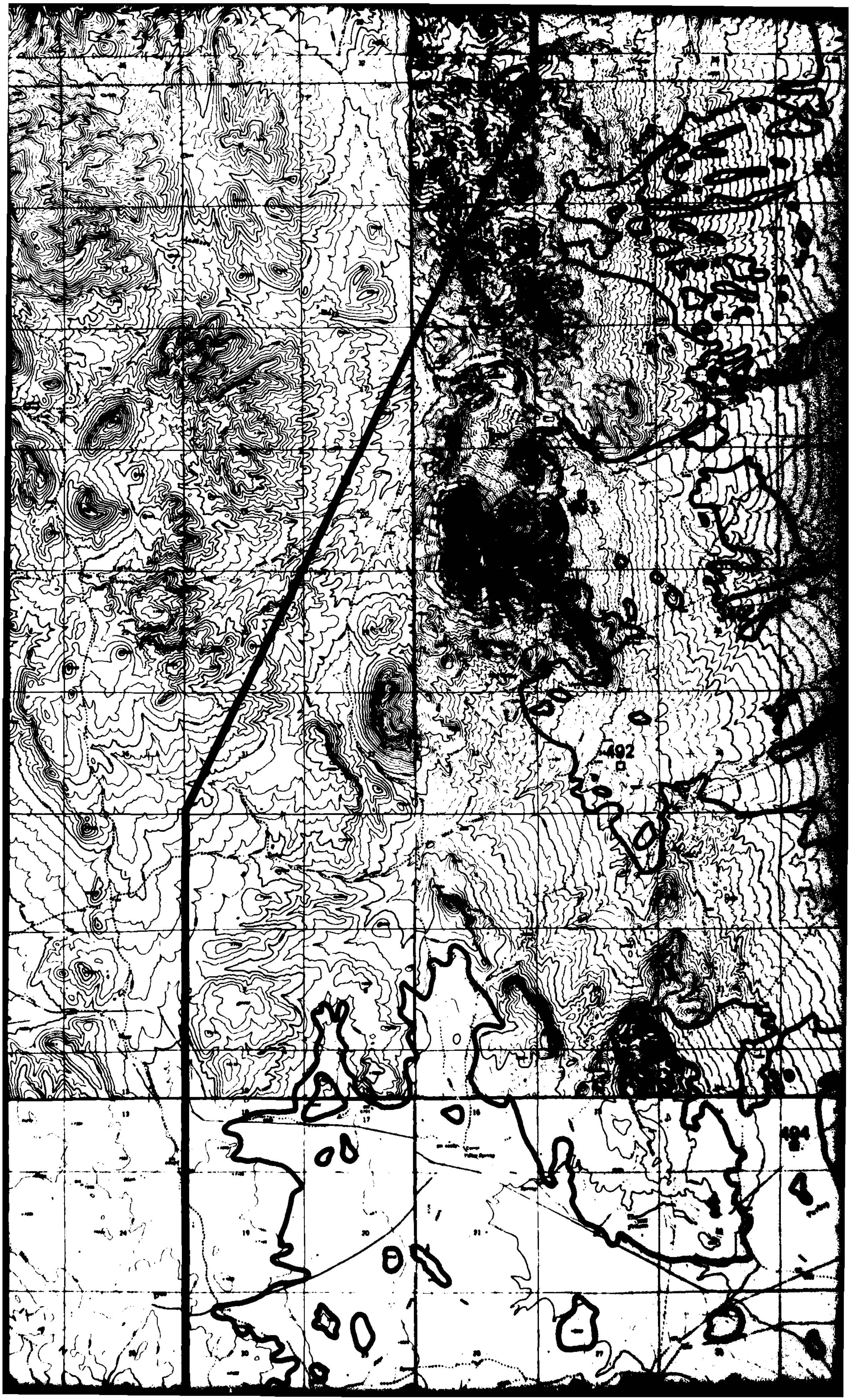
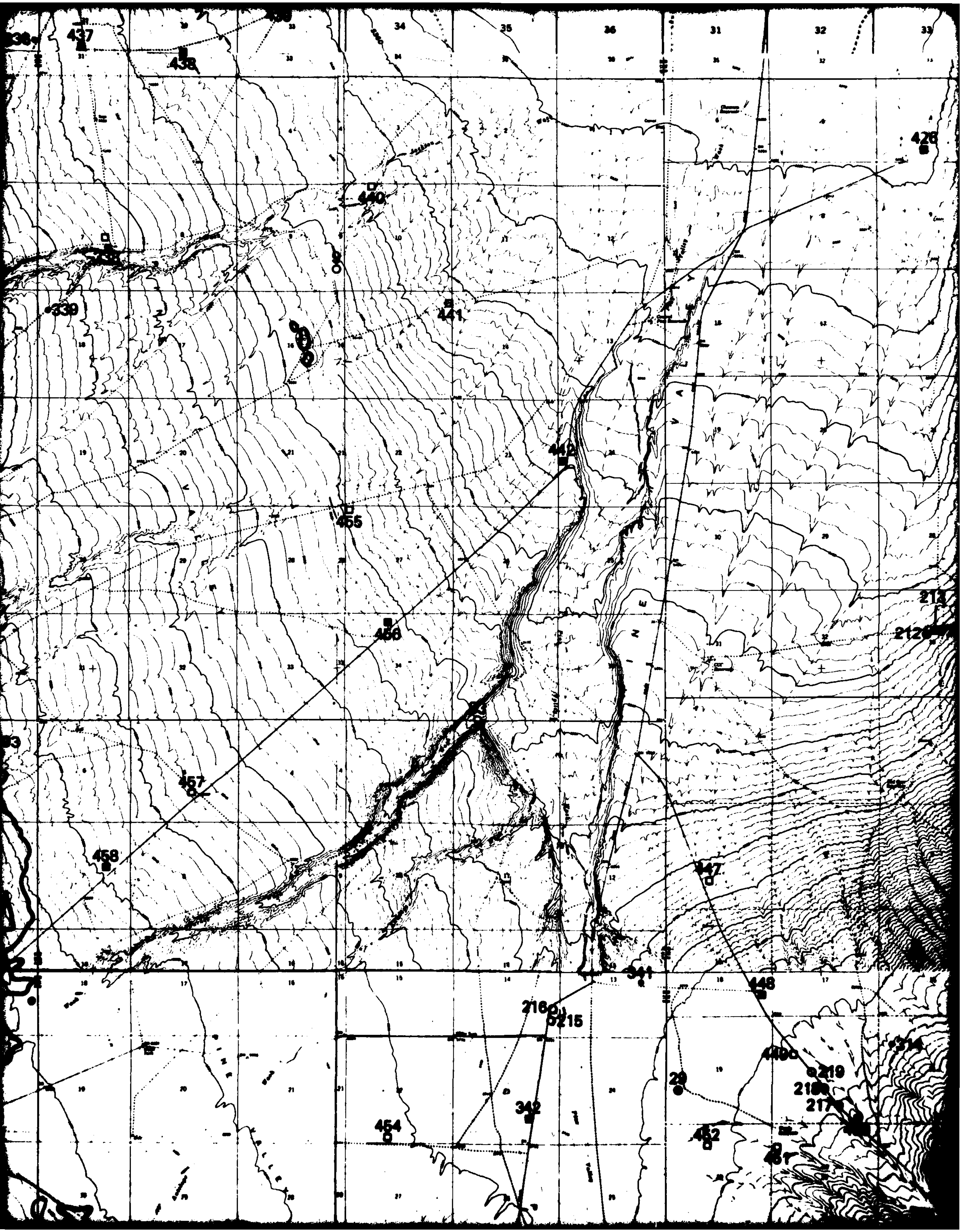


RANGE
EXPERIMENTAL
STATION
Experimental Plot
Guyman Well
BM 5097
PINE VALLEY
Range Headquarters
FENCE
MILLARD CO
BEAVER CO
Desert Ranch Reservoir
BM 5170
Electric Fence Reservoir
Cow Camp Well
BM 5207
BM 5214
Gravel Pit
Cow Track Reservoir
BM 5105
BM 5193
5125
5076


27
26
34
35
Canal
6



492
494



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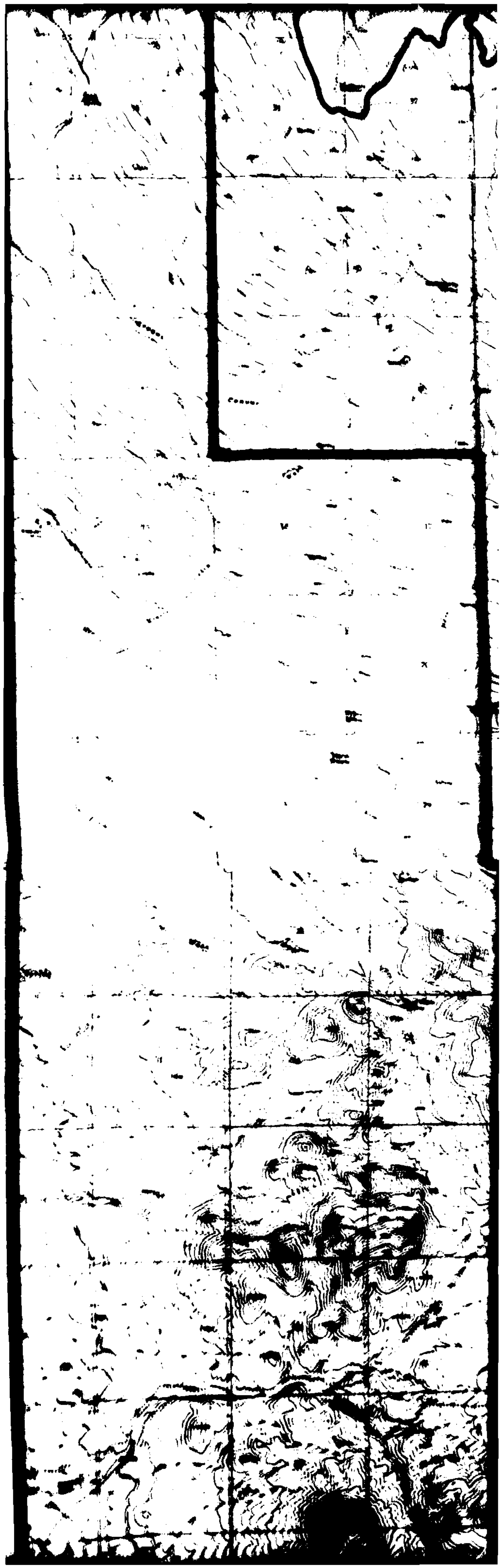

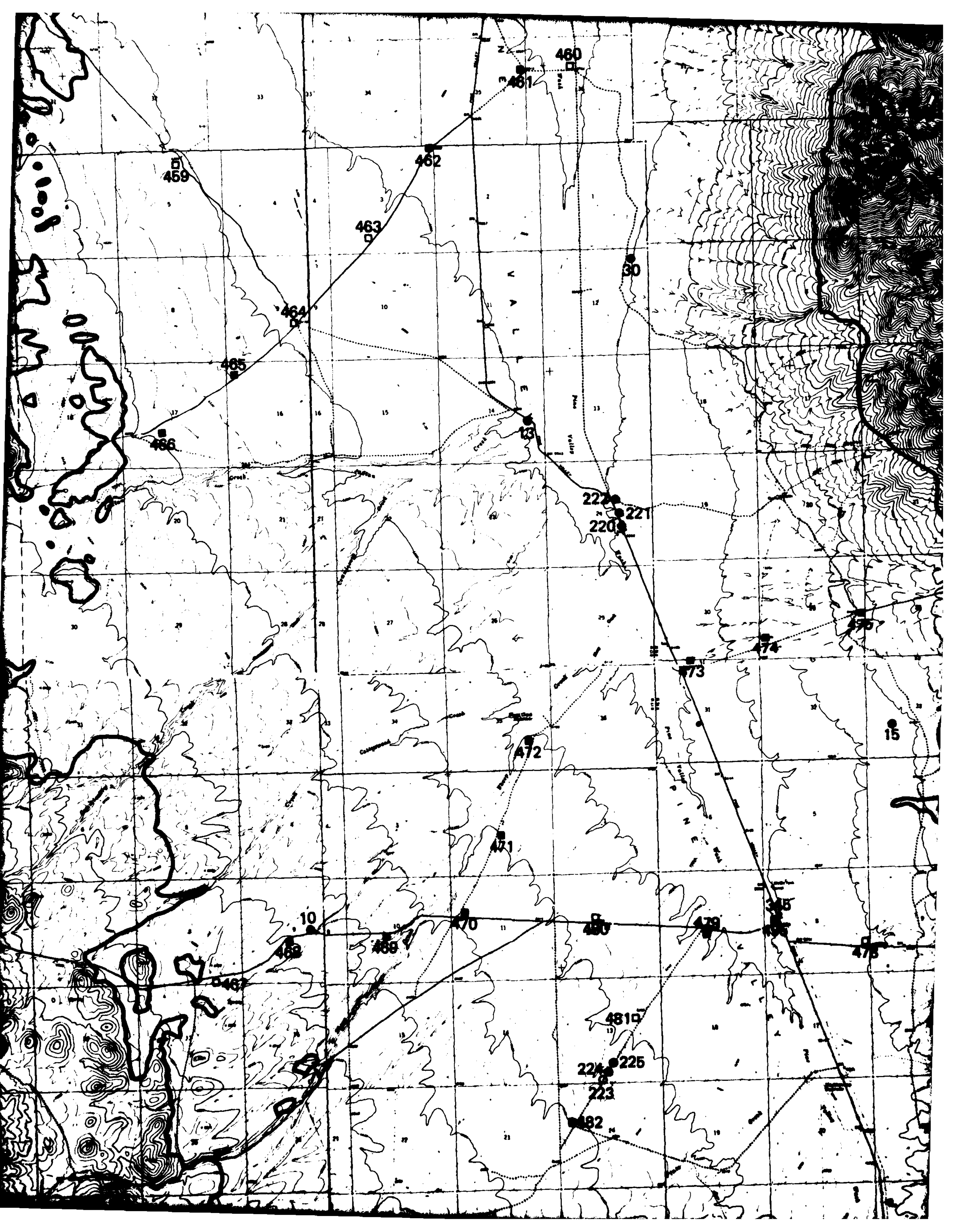
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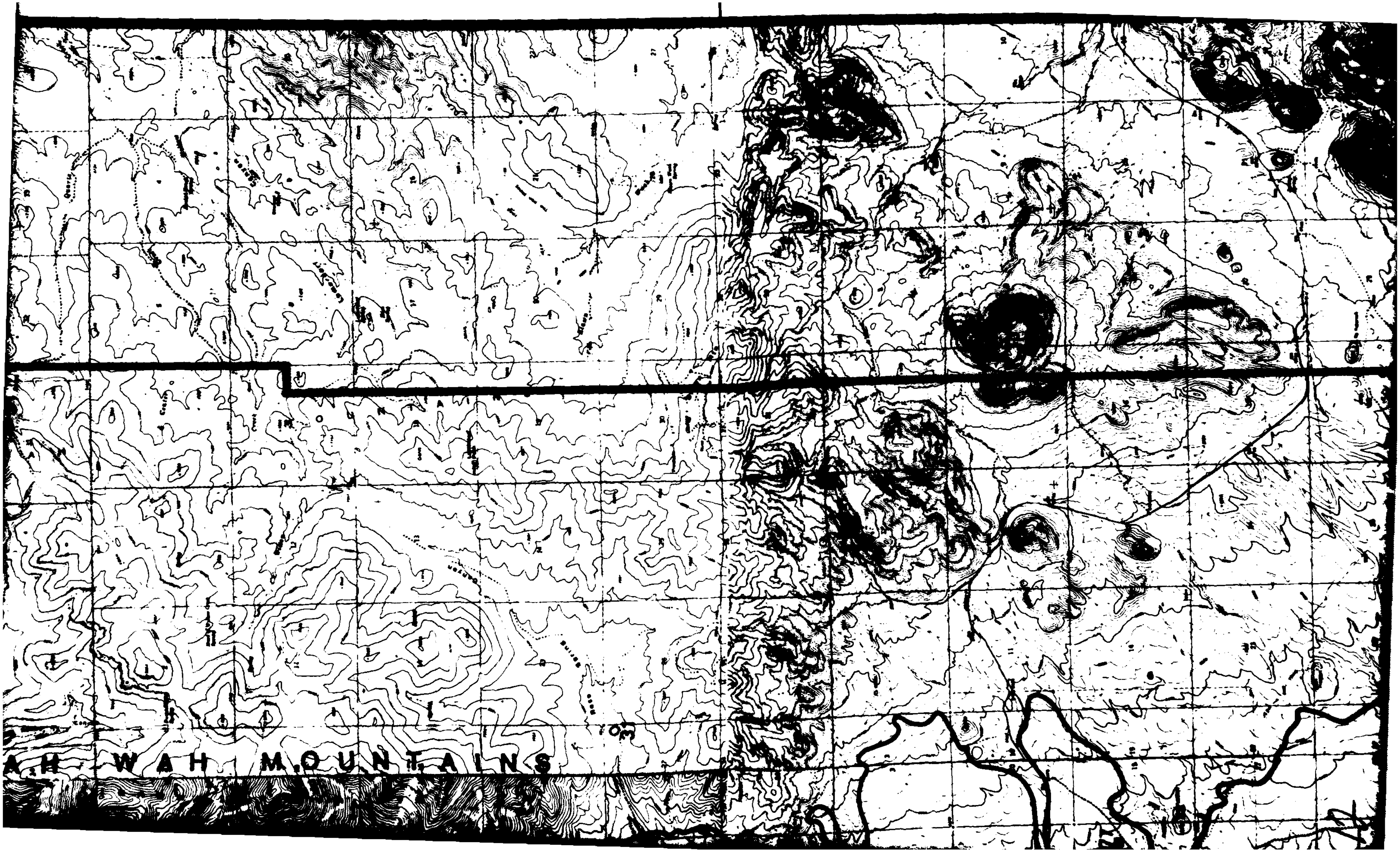
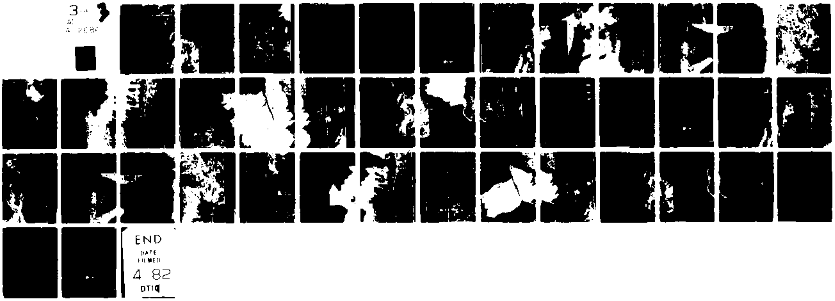
482

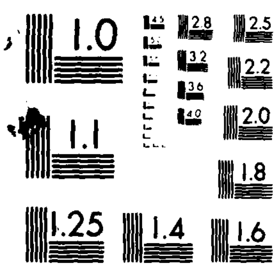

AH WAH MOUNTAINS

AD-A112 686 ERTEC WESTERN INC LONG BEACH CA F/G 8/7
MX SITING INVESTIGATION GEOTECHNICAL EVALUATION. DETAILED AGGRE--ETC(U)
JUN 81 F04704-80-C-0006
UNCLASSIFIED E-TR-47-PI NL

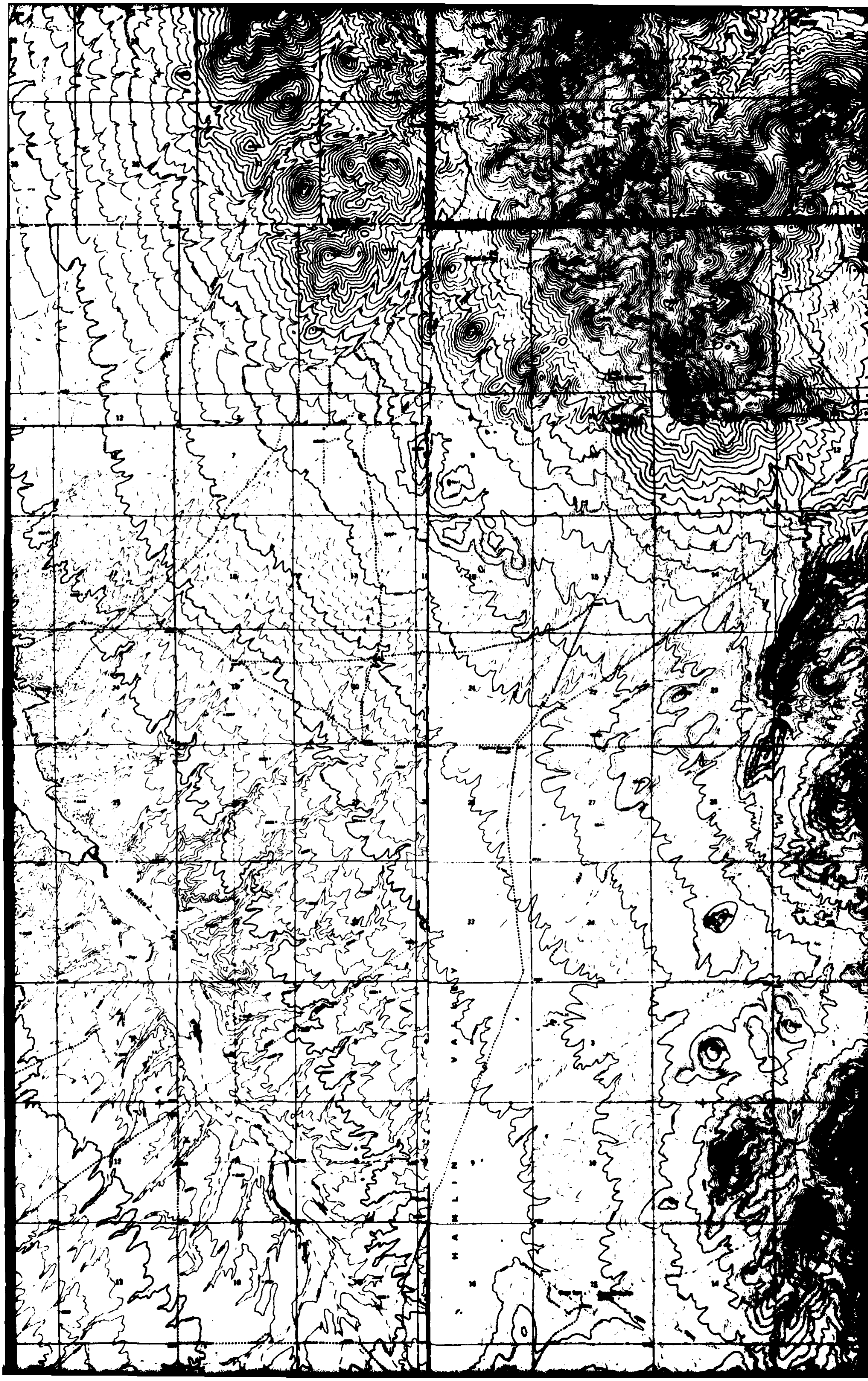


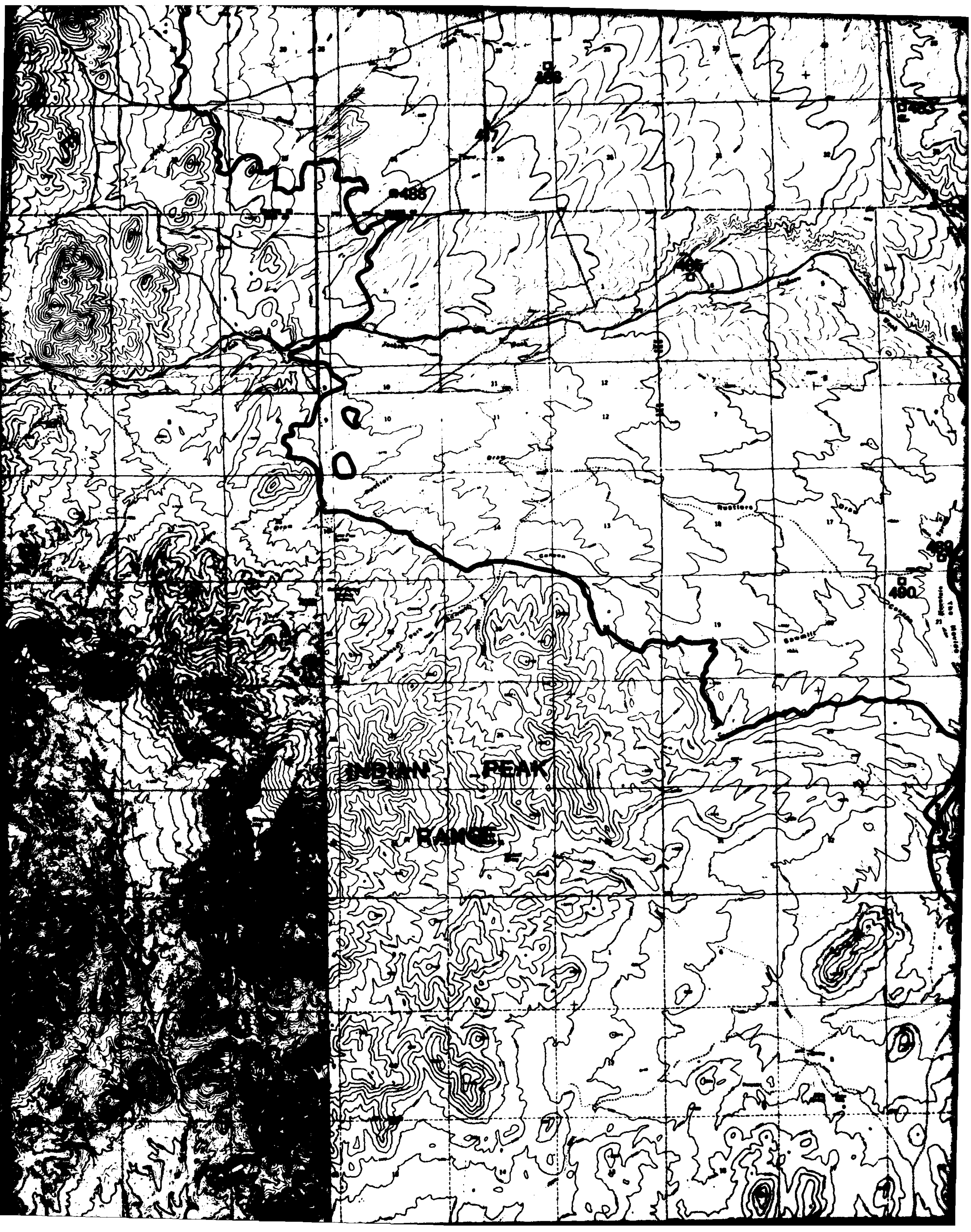
3 OF 3

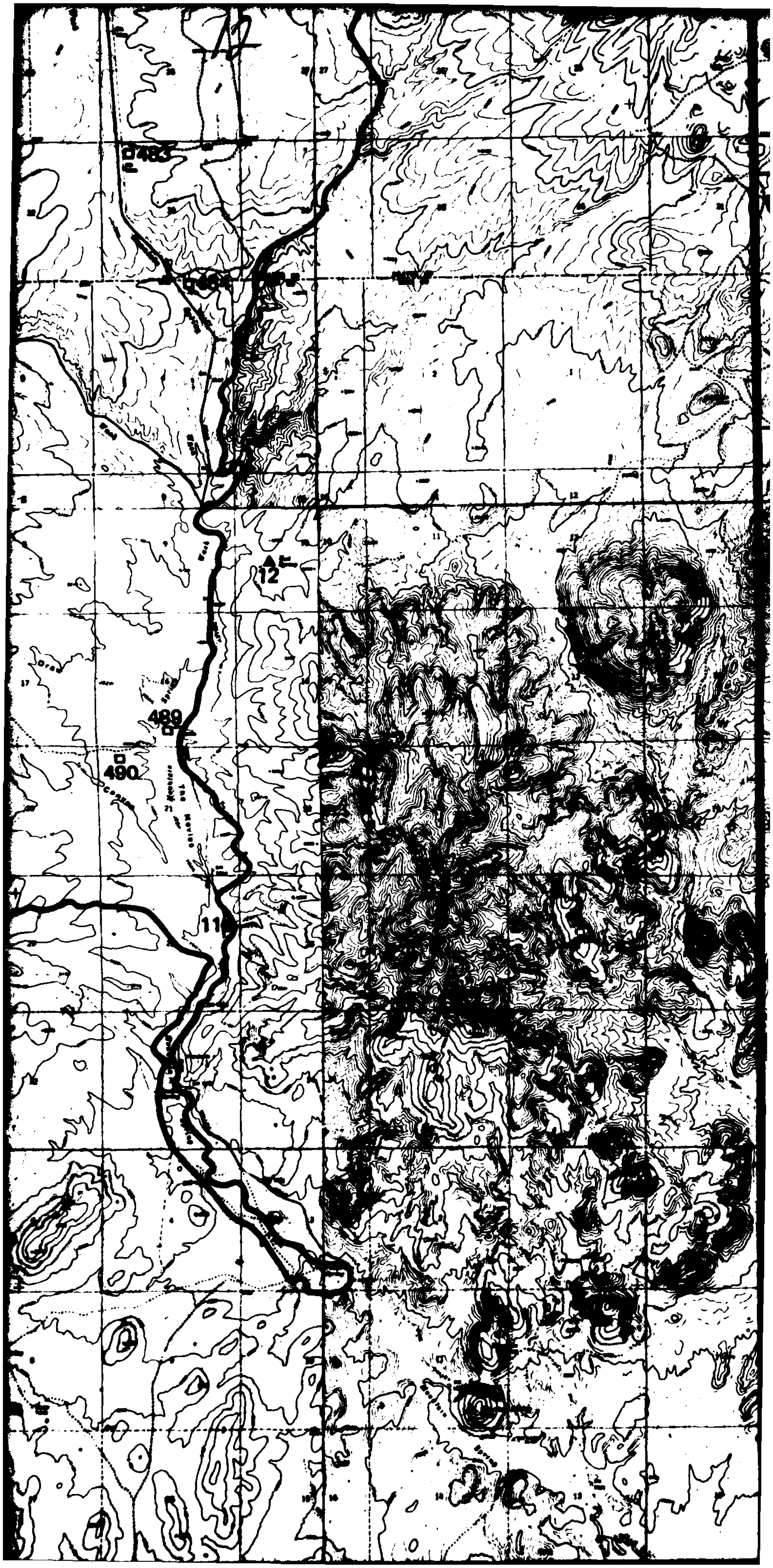
AD-A112686



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A




INDIAN PEAK
RANGE
488
490


483
484
12
489
490
11

ERTEC WESTERN AGGREGATE RESOURCES STUDY FIELD STATIONS

VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY*
(MAP NUMBERS FROM 1 TO 199)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

- ● DATA STOP, SAMPLED AND TESTED
- ○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

- ▲ DATA STOP, SAMPLED AND TESTED
- △ DATA STOP

DETAILED AGGREGATE RESOURCES STUDY**
(MAP NUMBERS FROM 200 TO 299 FOR BASIN–FILL AND ROCK SAMPLE LOCATIONS; 300 TO 399 FOR FIELD PETROGRAPHIC STATIONS)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

- ● DATA STOP, SAMPLED AND TESTED
- ○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

- ▲ DATA STOP, SAMPLED AND TESTED

PETROGRAPHIC FIELD STATIONS

- • DATA STOP

113° 45'

EXPLANATION

EXISTING ERTEC WESTERN TEST DATA LOCATIONS ***
(MAP NUMBERS FROM 400 TO 599)

- ■ DATA STOP, SAMPLED AND TESTED
- □ DATA STOP

* SEE PINE VALLEY, WAH WAH VALLEY VSARS REPORT (FN-TR-37-g) FOR DETAILED INFORMATION.

** SEE CORRESPONDING MAP NUMBER IN APPENDICES A AND B FOR DETAILED INFORMATION.

*** SEE CORRESPONDING MAP NUMBER AND ACTIVITY TYPE IN APPENDIX G FOR REFERENCE TO PINE VALLEY VERIFICATION REPORT (FN-TR-27-PI-I AND II).

SYMBOLS

▬▬ STUDY AREA BOUNDARY

—— ROCK/BASIN–FILL CONTACT

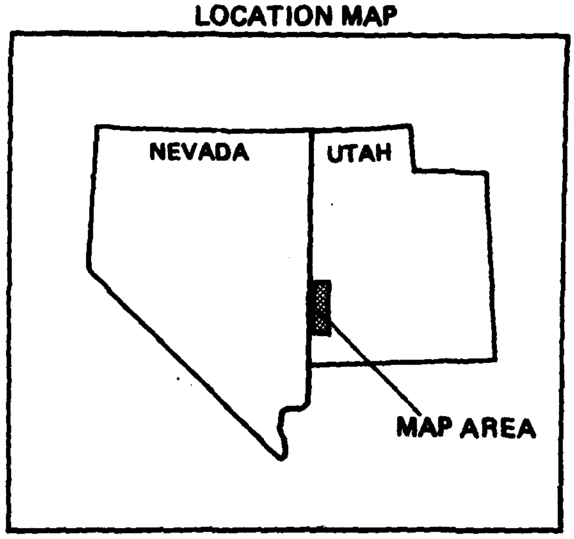
NORTH

SCALE 1:62,500

0 1 2
STATUTE MILES

0 1 2
KILOMETERS

LOCATION MAP



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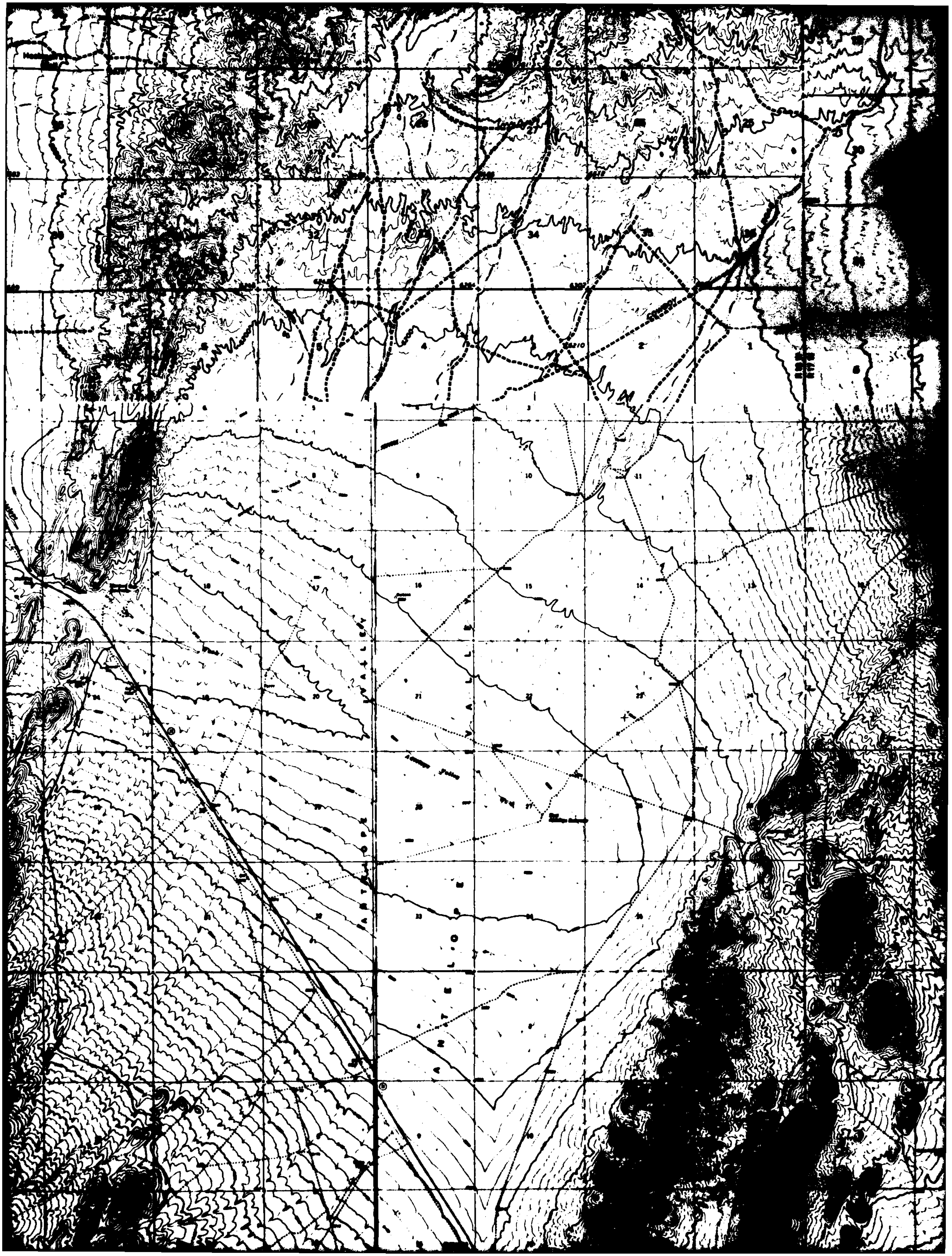
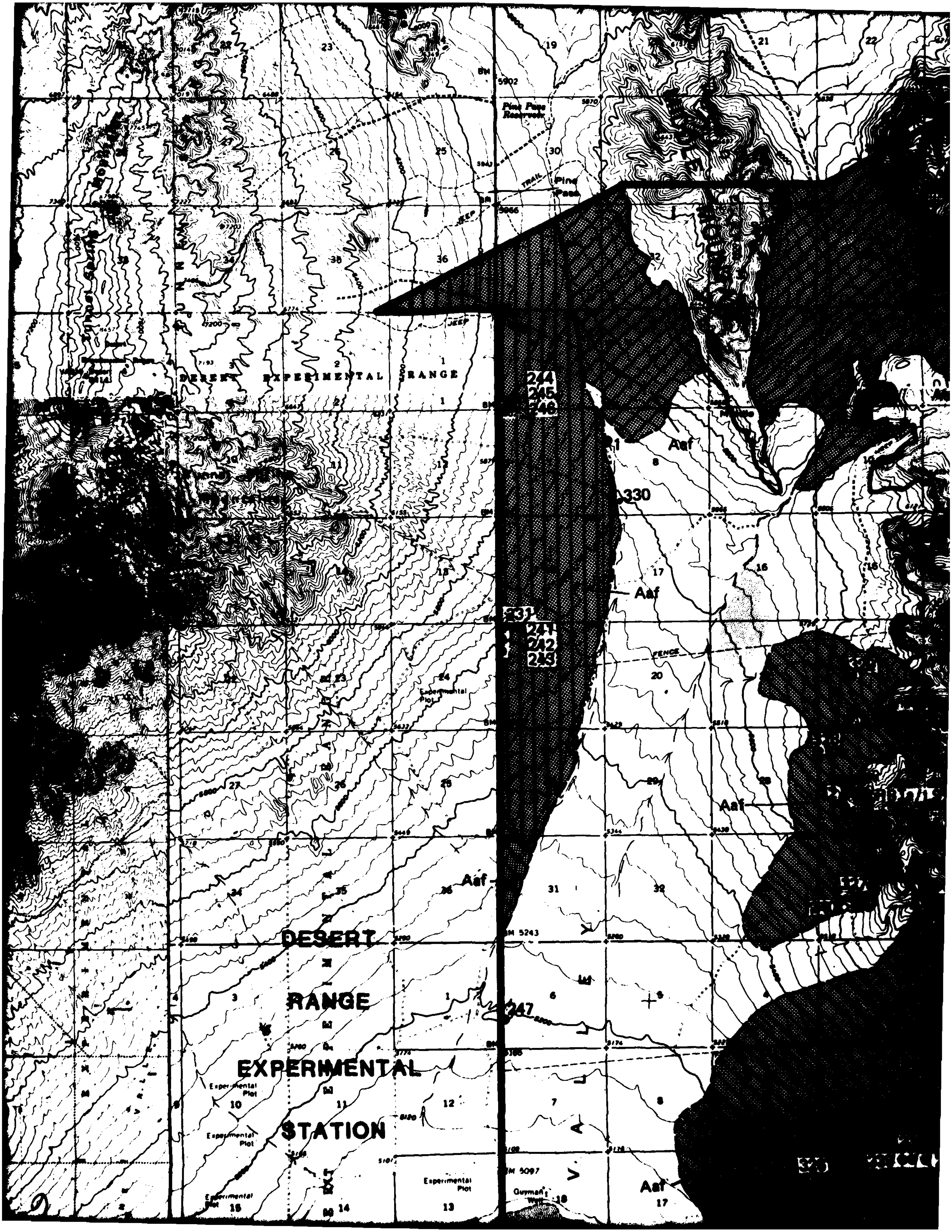
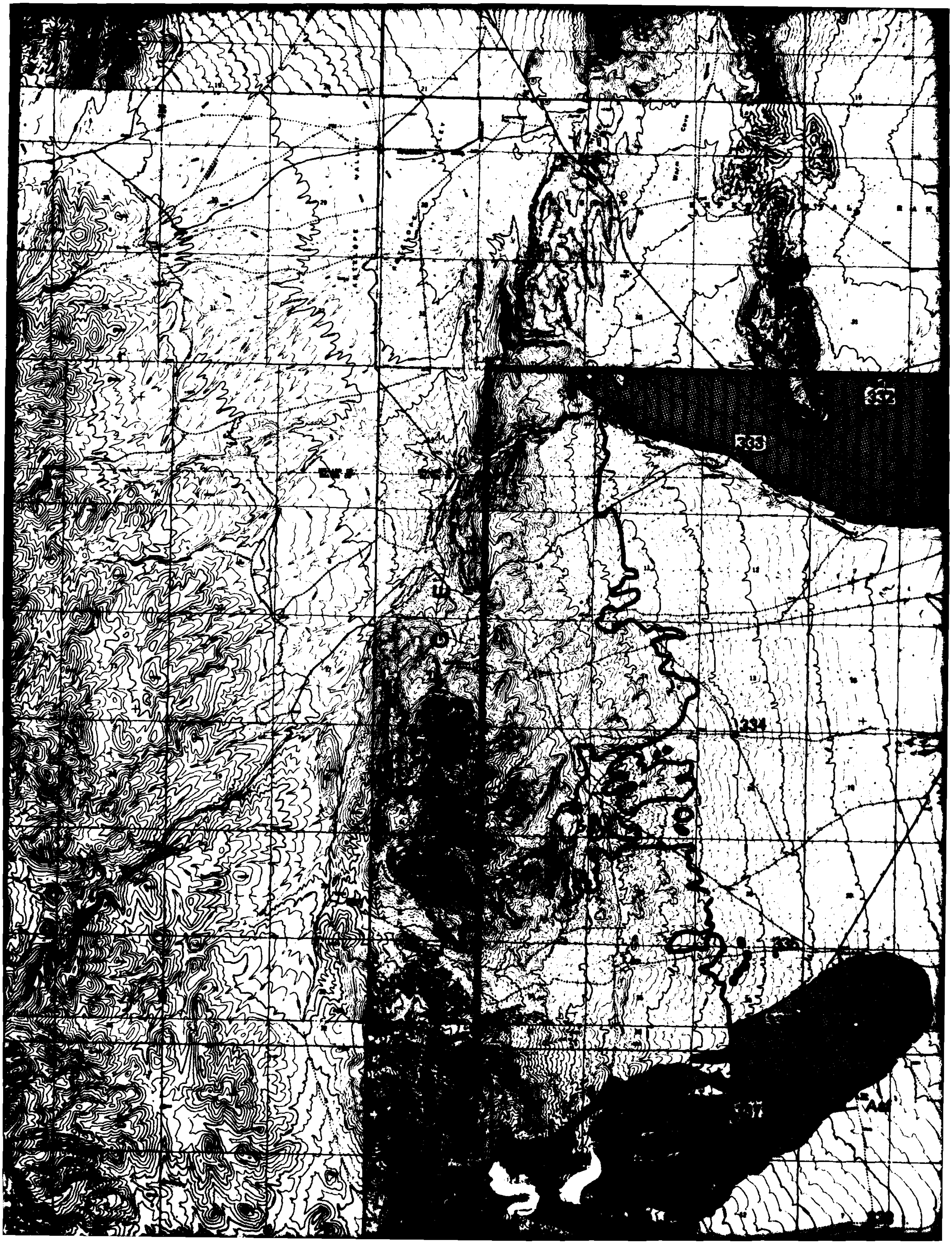
FIELD STATION AND SELECTED EXISTING DATA SITE LOCATIONS DETAILED AGGREGATE RESOURCES STUDY PINE VALLEY, UTAH





Pine Pass Reservoir
Pine Pass
TRAIL
JEEP
DESERT EXPERIMENTAL RANGE
244
245
246
Aaf
330
231
241
242
243
FENCE
Experimental Plot
DESERT
RANGE
EXPERIMENTAL
STATION
247
BM 5243
BM 5097
Guyman's Well


Sand Pass
JEEP TRAIL
JEEP
Cave



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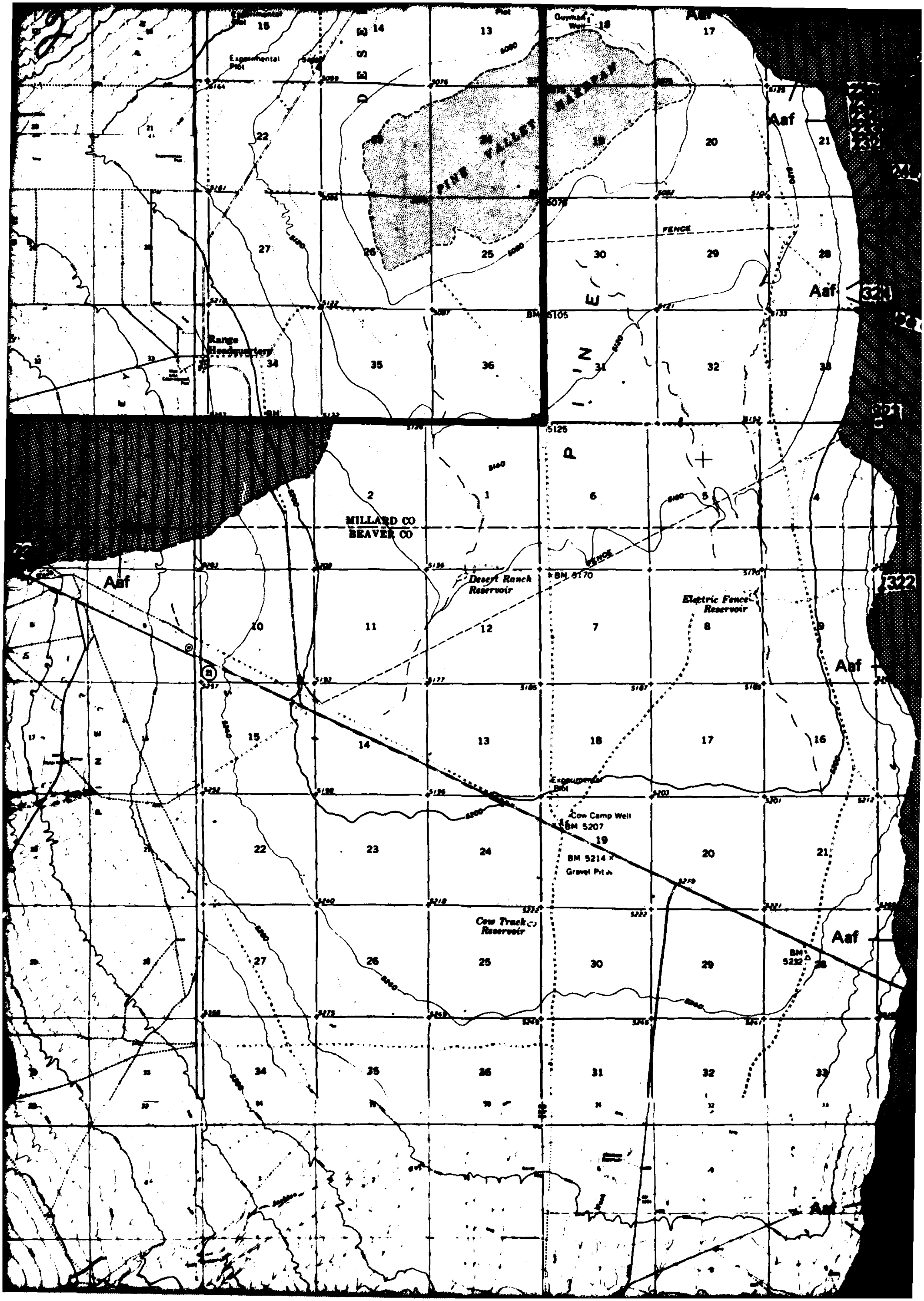
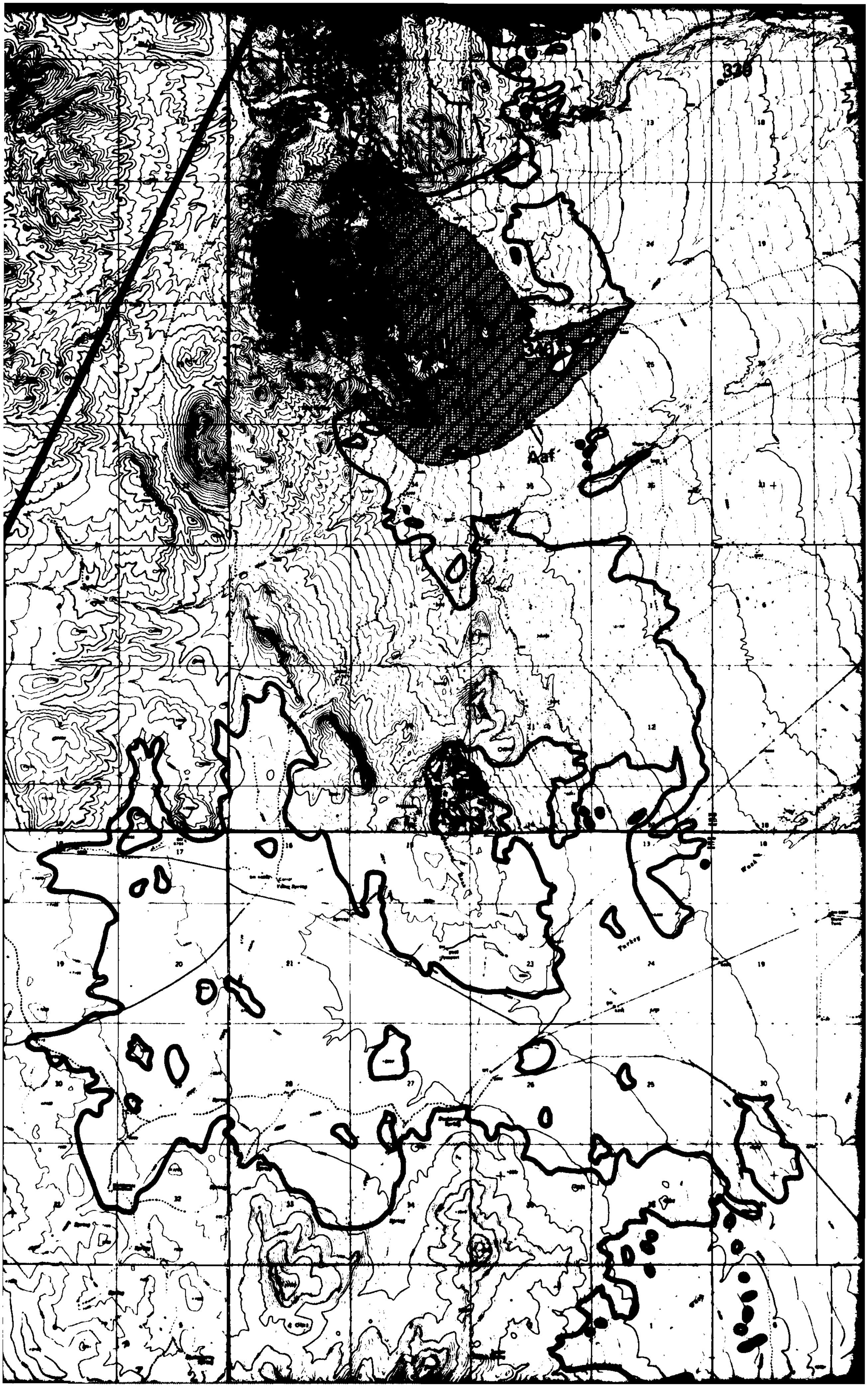
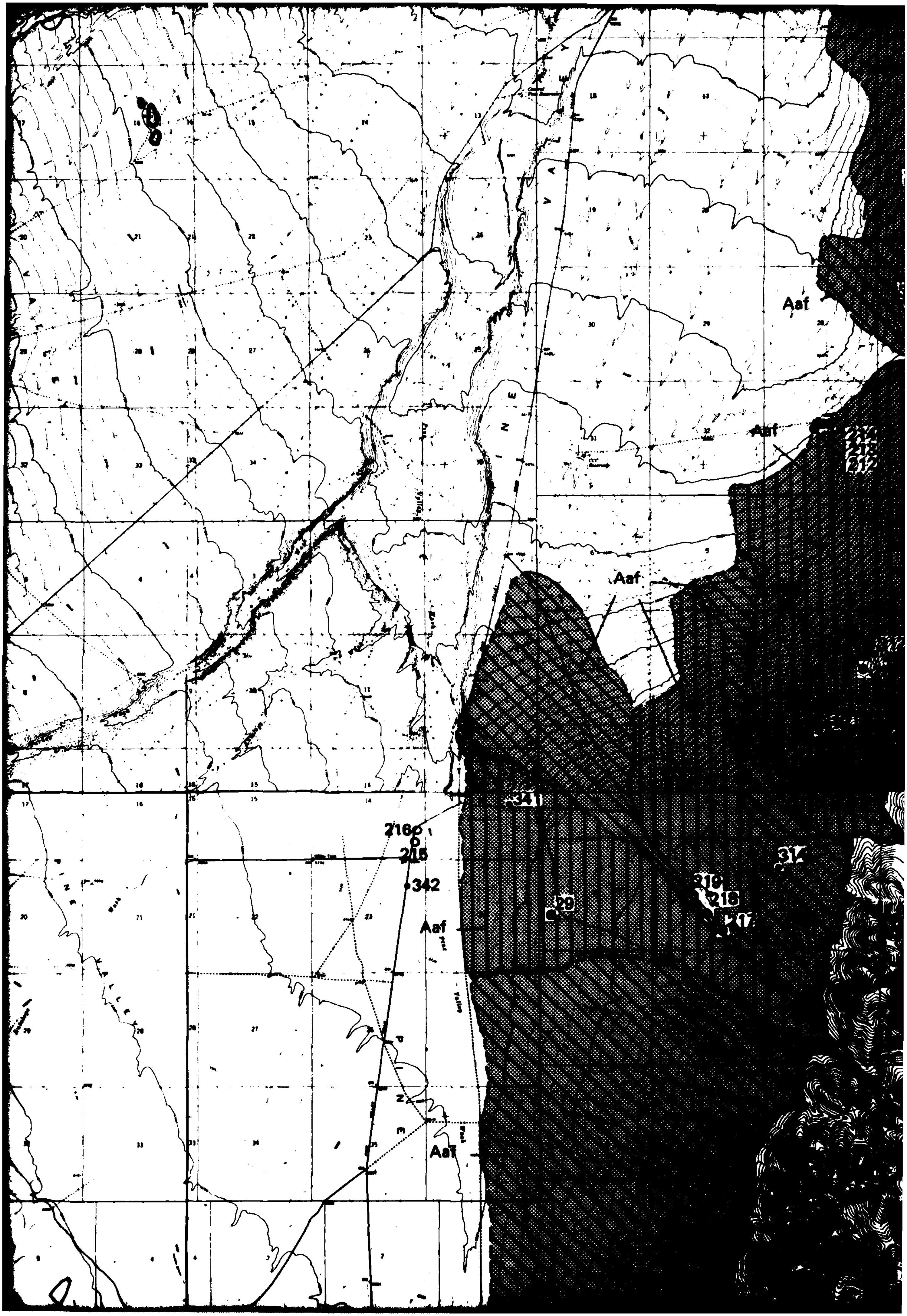
333
334
335
337



Experimental Plot
Guyman's Well
Aaf
PINE VALLEY
Range Headquarters
FENCE
BM 5105
5125
MILLARD CO
BEAVER CO
Desert Ranch Reservoir
BM 5170
Electric Fence Reservoir
Experimental Plot
Cow Camp Well
BM 5207
BM 5214
Gravel Pit
Cow Track Reservoir
BM 5232
322


Aaf


Aaf
Aaf
Aaf
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Aaf
219
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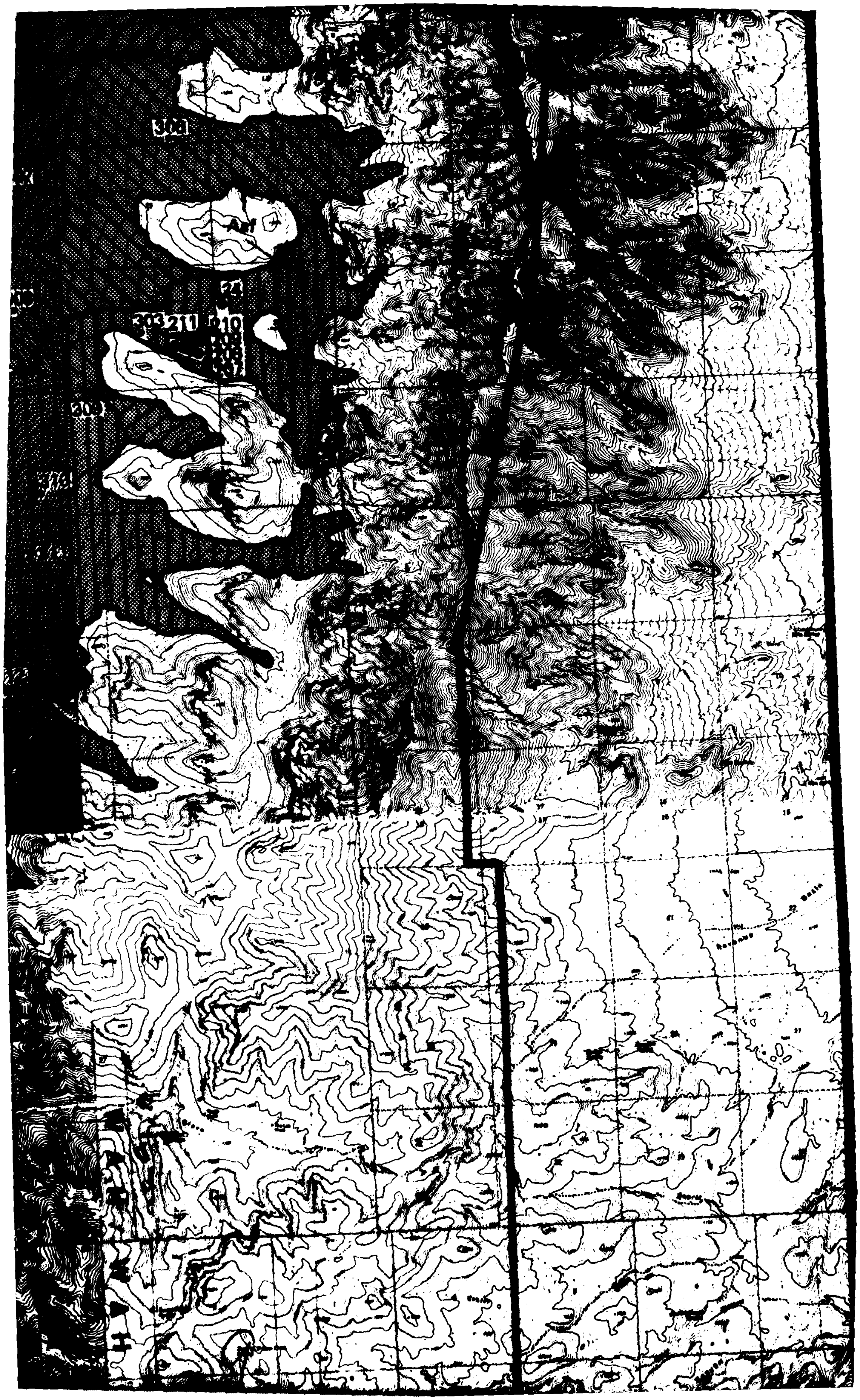
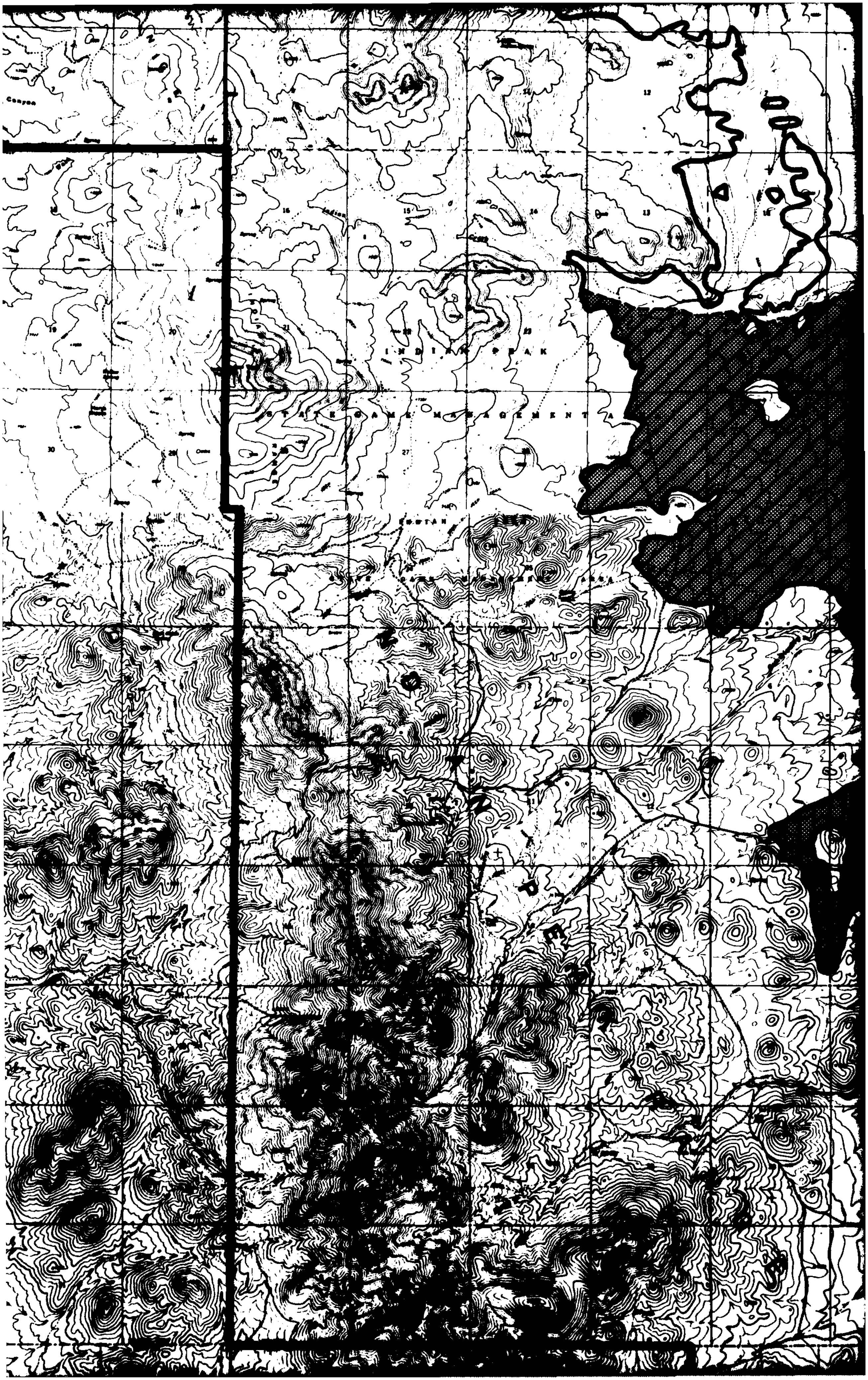
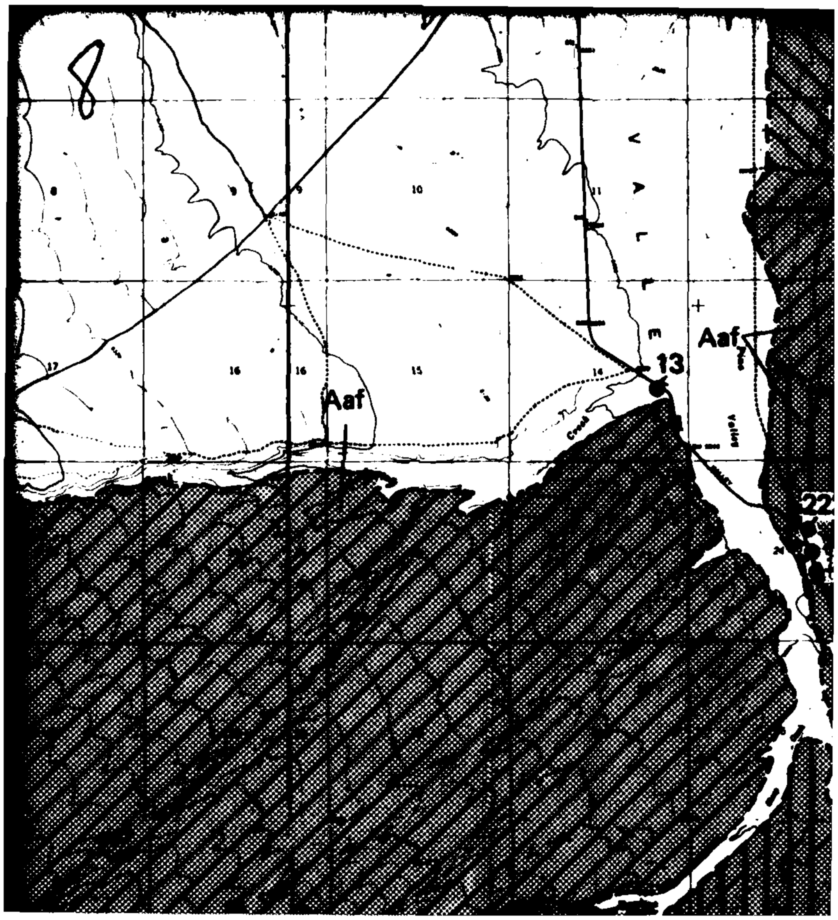
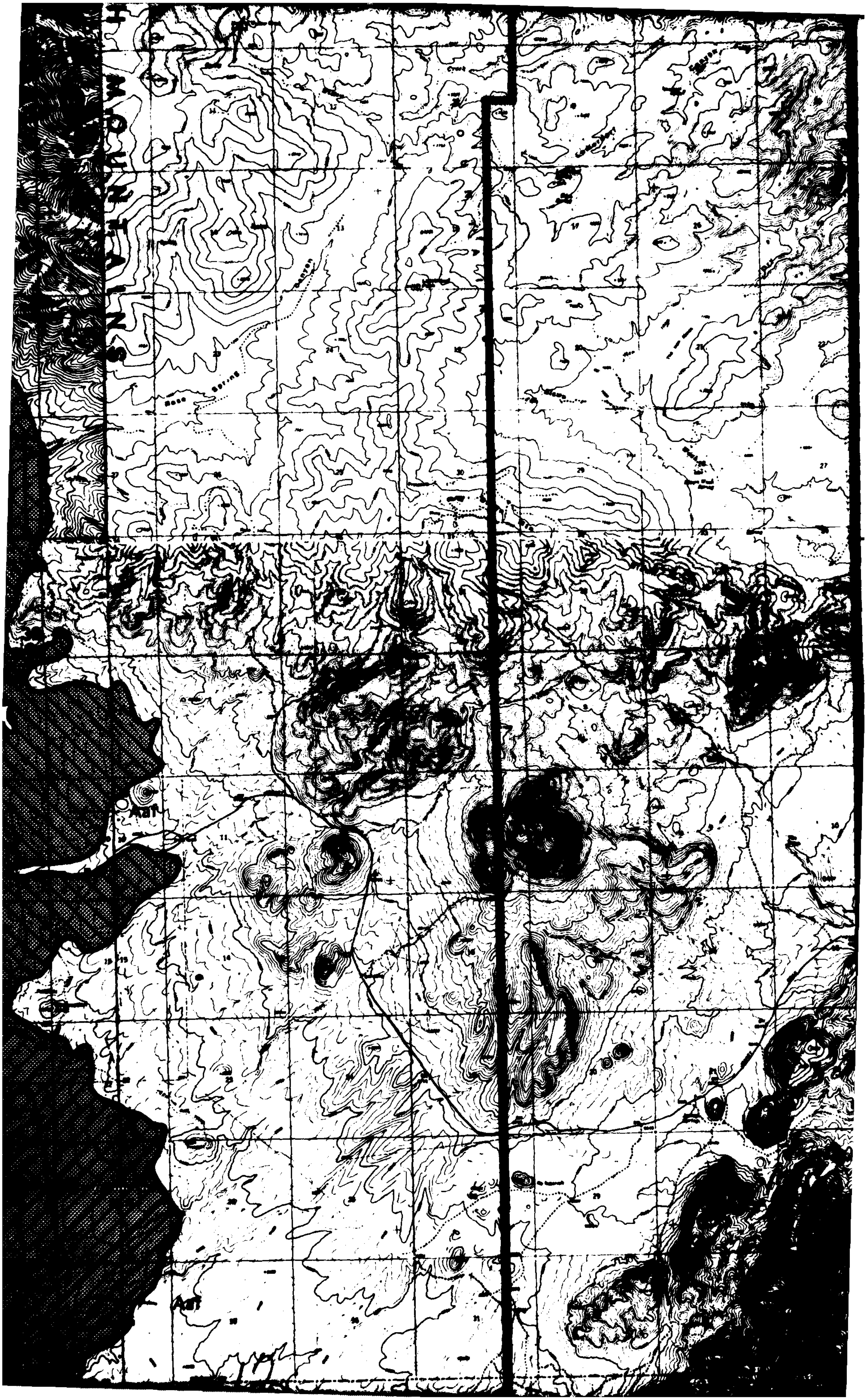
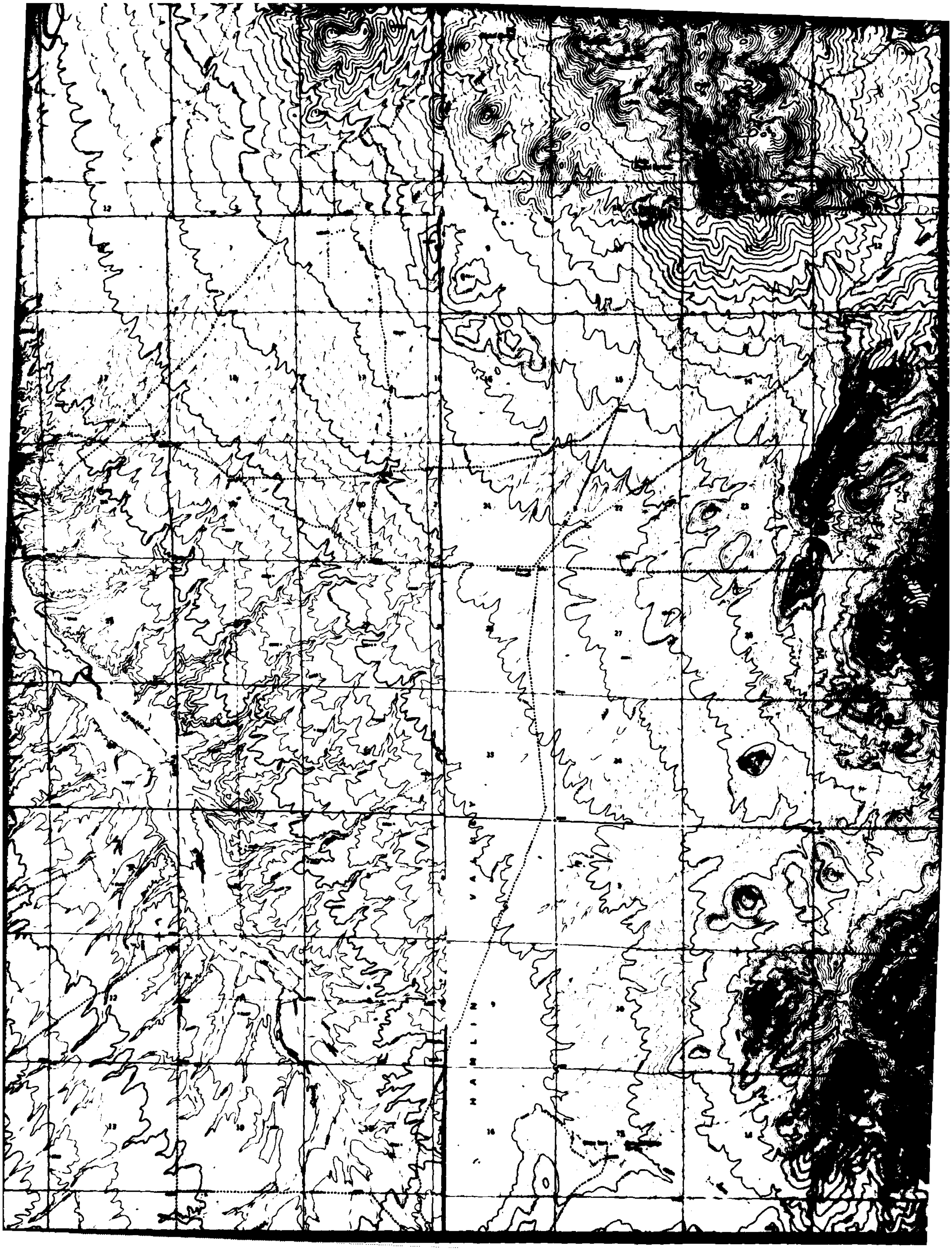
314
Aaf

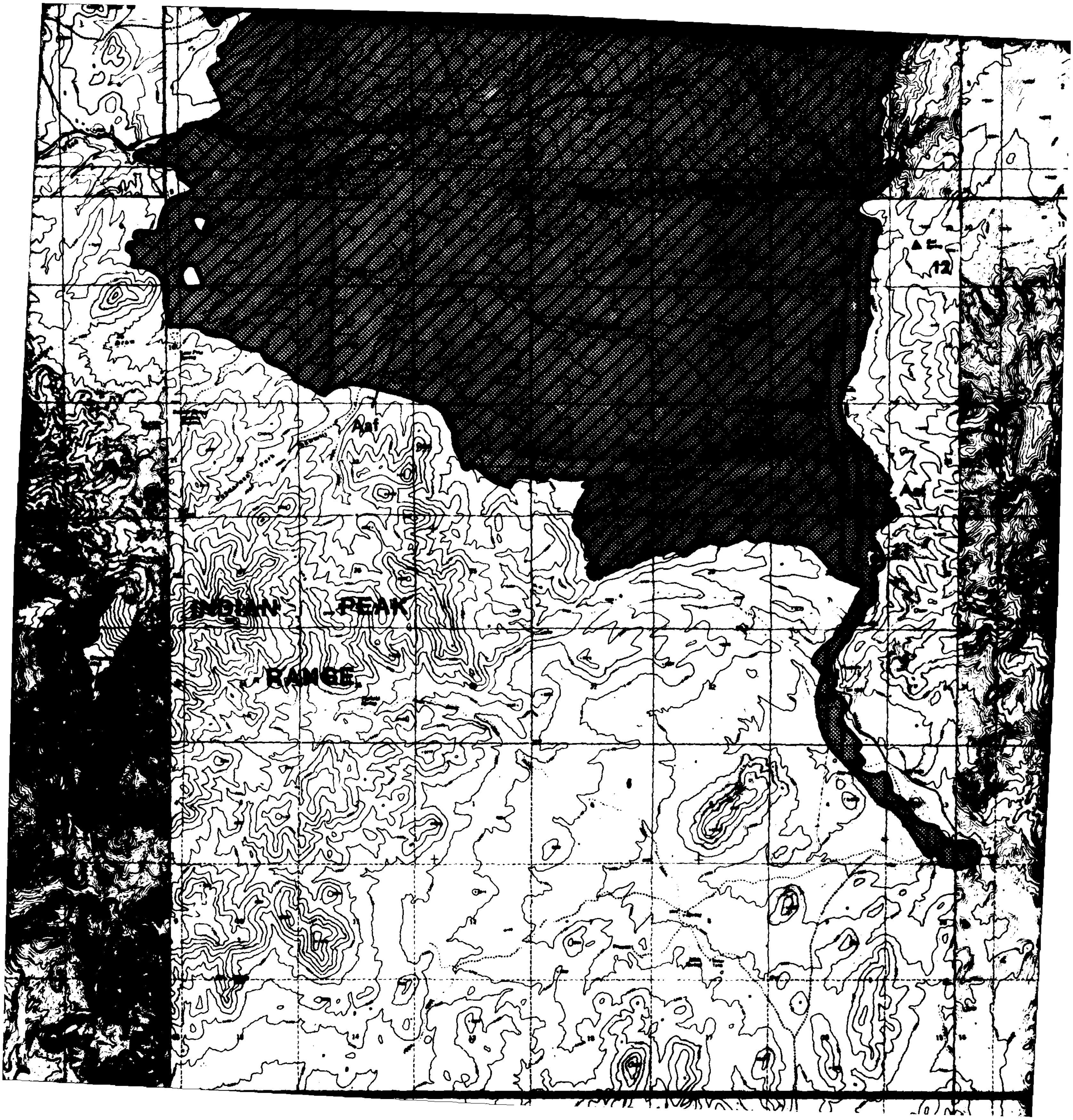


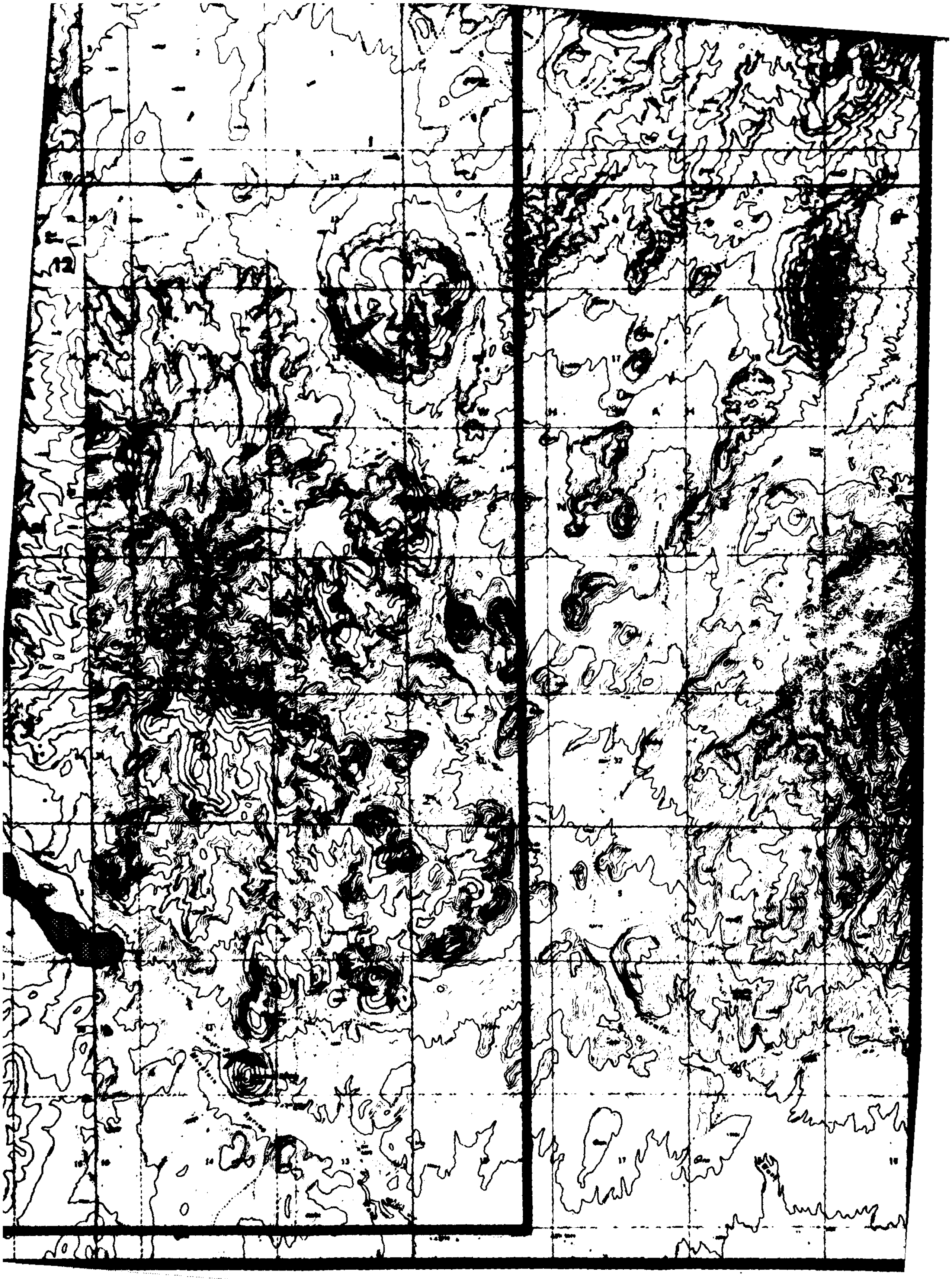

Canyon
INDIAN PEAK


8
VALLE
13
Aaf
Aaf
22


Aaf
Aaf




INDIAN PEAK
RANGE



ERTEC WESTERN AGGREGATE RESOURCES STUDY FIELD STATIONS

VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY*
(MAP NUMBERS FROM 1 TO 199)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

DATA STOP, SAMPLED AND TESTED

DETAILED AGGREGATE RESOURCES STUDY**
(MAP NUMBERS FROM 200 TO 299 FOR BASIN–FILL
AND ROCK SAMPLE LOCATIONS; 300 TO 399 FOR
FIELD PETROGRAPHIC STATIONS)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

PETROGRAPHIC FIELD STATIONS

• DATA STOP

* SEE PINE VALLEY, WAH WAH VALLEY VSARS
REPORT (FN-TR-37-g) FOR DETAILED INFORMATION.

** SEE CORRESPONDING MAP NUMBER IN APPENDICES A AND B
FOR DETAILED INFORMATION.

BASIN–FILL AND ROCK

RBIa BASIN
ROCK

RBIb BASIN

RBII BASIN

EXPLANATION

14

ATION SYSTEM

SOURCES

FILL

BASIN—FILL OR ROCK SOURCES CONTAINING MATERIALS SUITABLE FOR USE AS ROAD-BASE AGGREGATES; BASED ON ACCEPTABLE LABORATORY AGGREGATE TEST RESULTS.

FILL

BASIN—FILL SOURCES CONTAINING MATERIALS SUITABLE FOR USE AS ROAD-BASE AGGREGATES; BASED ON CORRELATION WITH CLASS RBIa SOURCE AREAS.

FILL

POTENTIAL BASIN—FILL SOURCES OF MATERIALS SUITABLE FOR USE AS ROAD-BASE AGGREGATES; BASED ON PHOTOGEOLOGIC INTERPRETATIONS, FIELD OBSERVATIONS, AND LIMITED OR INCONCLUSIVE SIEVE ANALYSIS AND/OR ABRASION DATA.

UNSUITABLE SOURCES OF BASIN—FILL MATERIALS THAT MAY LOCALLY CONTAIN POTENTIALLY SUITABLE SOURCES OF AGGREGATES OF LIMITED EXTENT. UNTESTED SOURCES OF ROCK MATERIALS THAT MAY CONTAIN POTENTIALLY SUITABLE CRUSHED-ROCK AGGREGATES (SEE TEXT FOR ADDITIONAL INFORMATION).

GEOLOGIC UNITS†

BASIN—FILL U

Aal STREAM-CHA

Aaf ALLUVIAL FA

ROCK UNITS

Qtz QUARTZITE

Ls LIMESTONE

Cau CARBONATE

†SEE APPENDIX TABLE F-3 FOR SY

SYMBOLS††

STUDY ARE

ROCK/BASIN

GEOLOGIC

BASIN—FIL

†† GEOLOGIC ROCK AND BASIN APPROXIMATELY LOCATED

NORTH

TS

SCALE 1:62,500

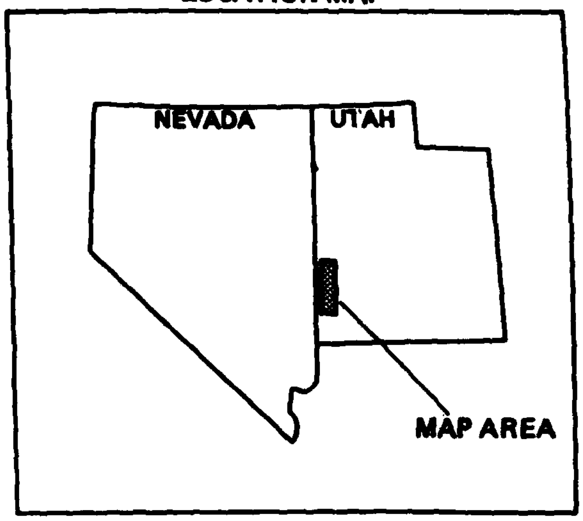
0 1 2
STATUTE MILES

0 1 2
KILOMETERS

EL AND/OR TERRACE DEPOSITS (A1/A2)

DEPOSITS (A5)

LOCATION MAP



(M4 AND/OR S1)

(S2)

ROCKS UNDIFFERENTIATED (S2)

YMBOL EXPLANATION AND COMPARISON.

A BOUNDARY

N–FILL CONTACT

ROCK CONTACT

L CONTACT

–FILL CONTACTS ARE
AND MAY VARY LOCALLY.

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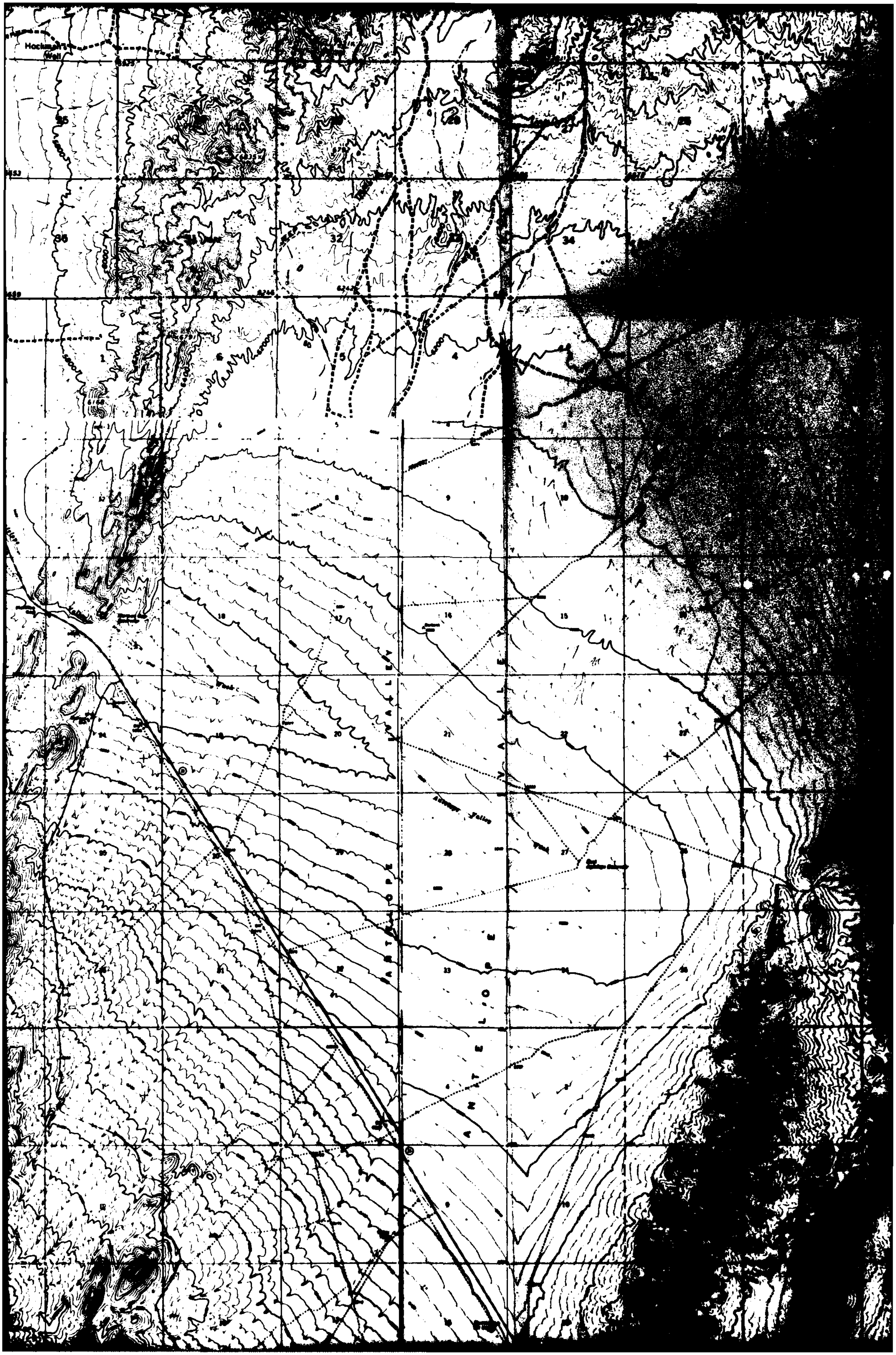
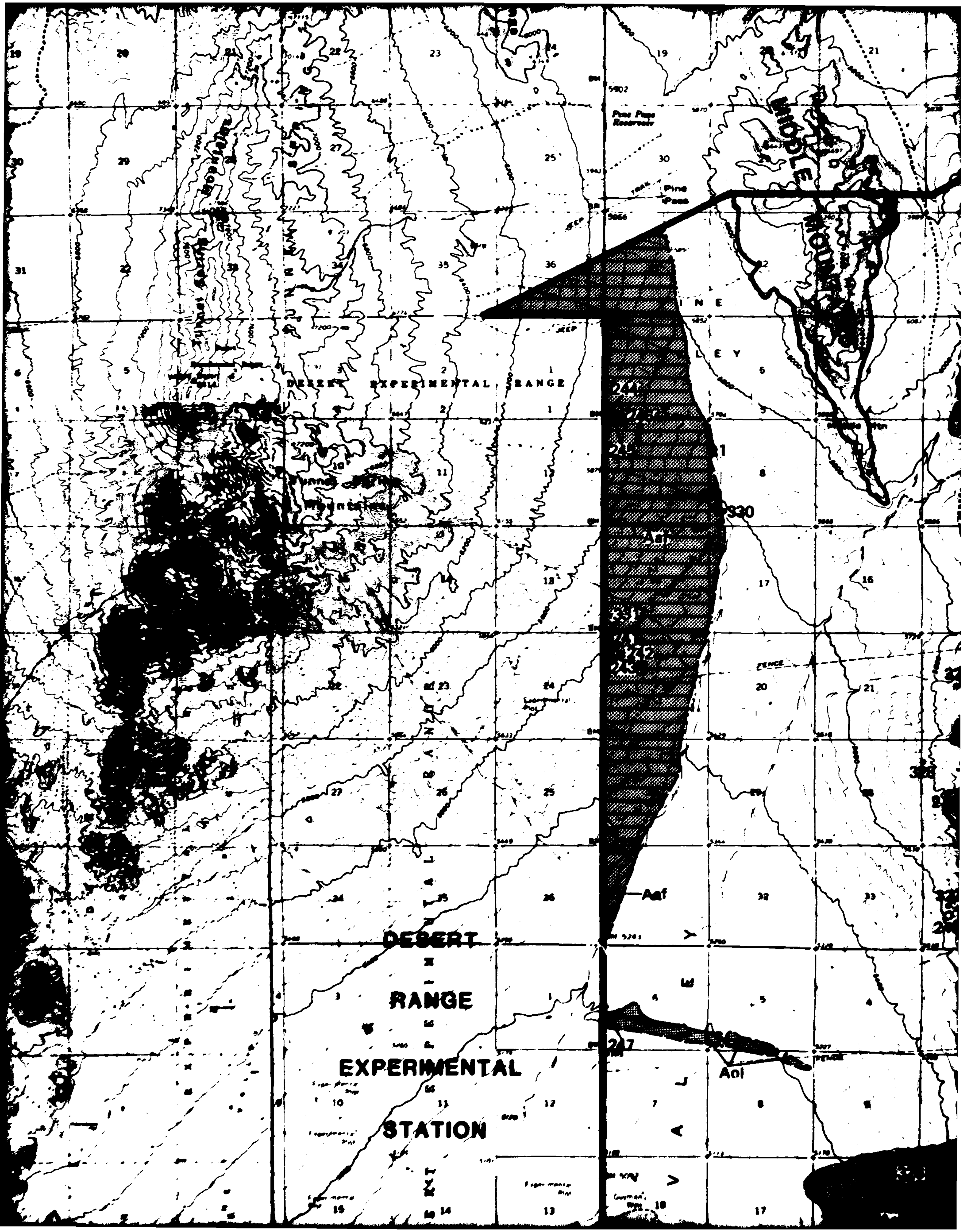
ROAD–BASE AGGREGATE RESOURCES MAP
DETAILED AGGREGATE RESOURCES STUDY
PINE VALLEY, UTAH

12 JUN 81

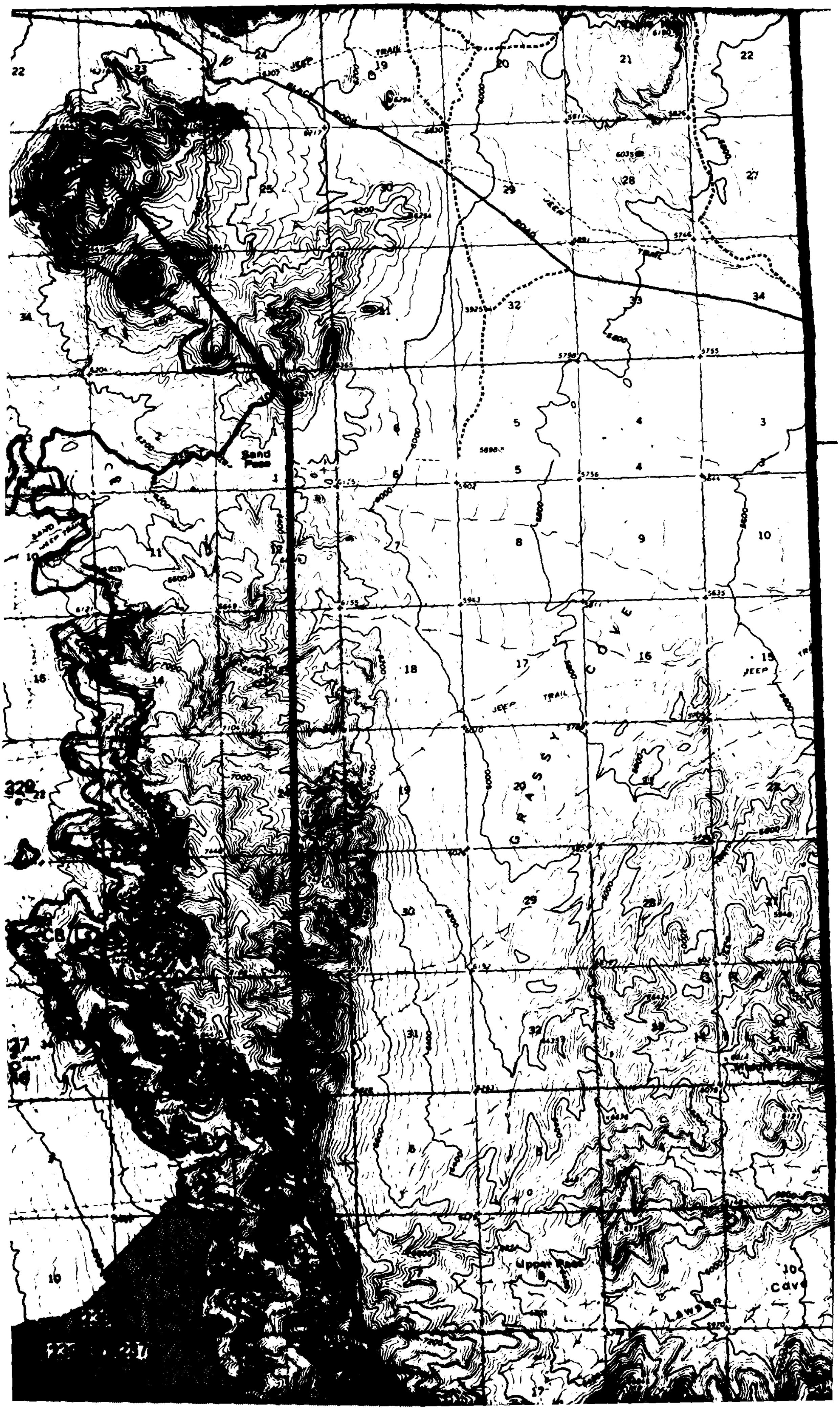
DRAWING 2

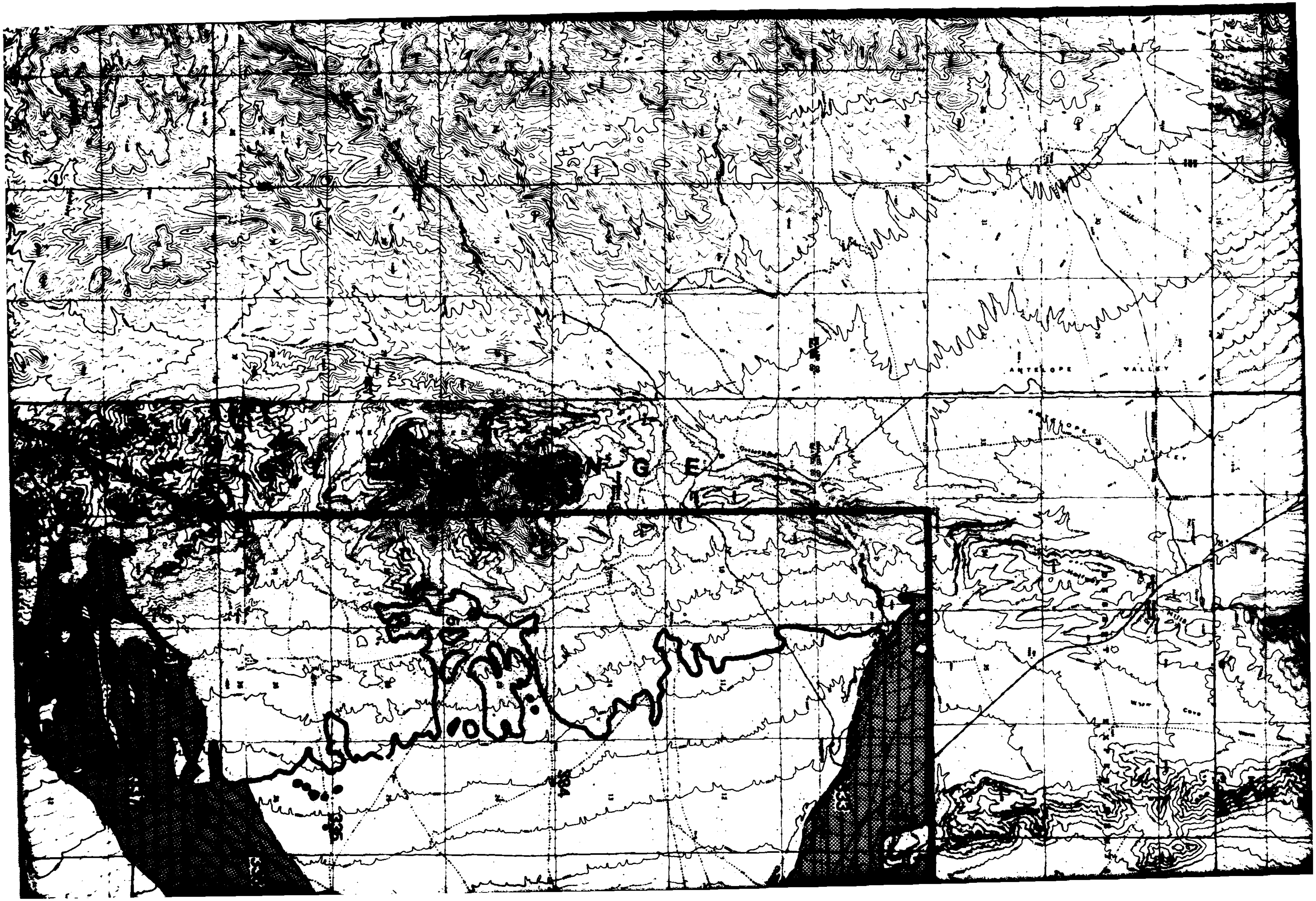


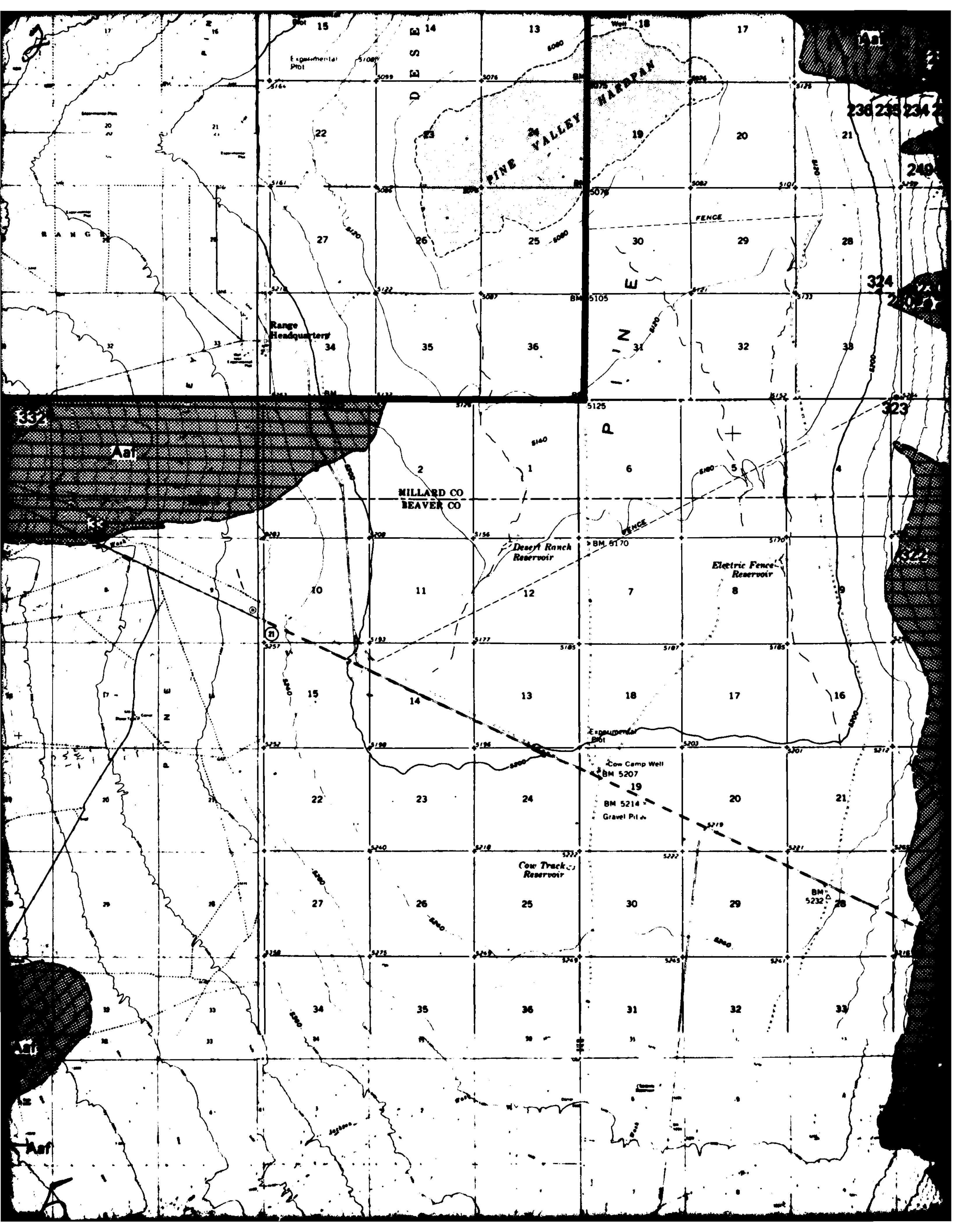
Hockman's Well
ANTELOPE VALLEY

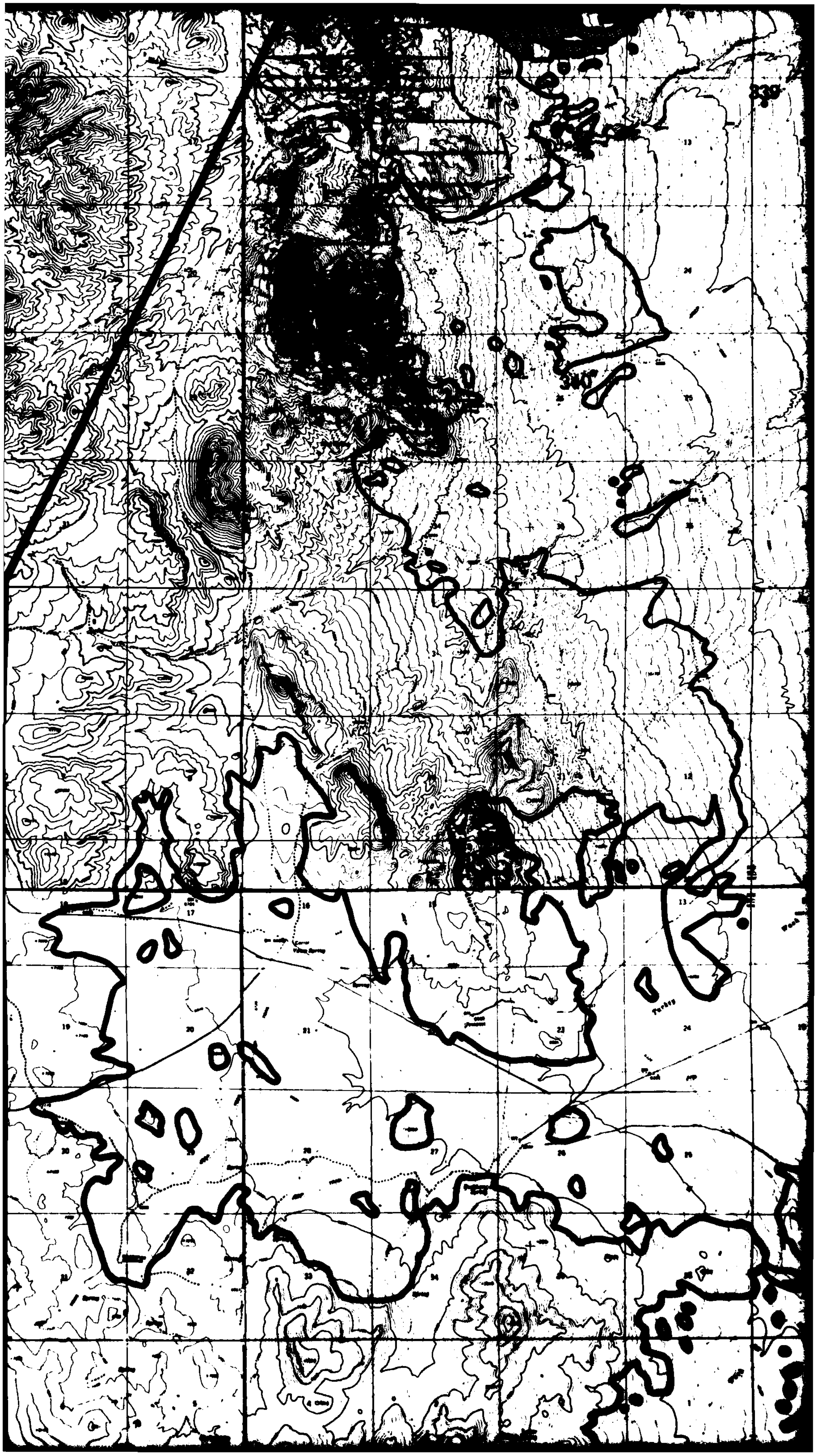


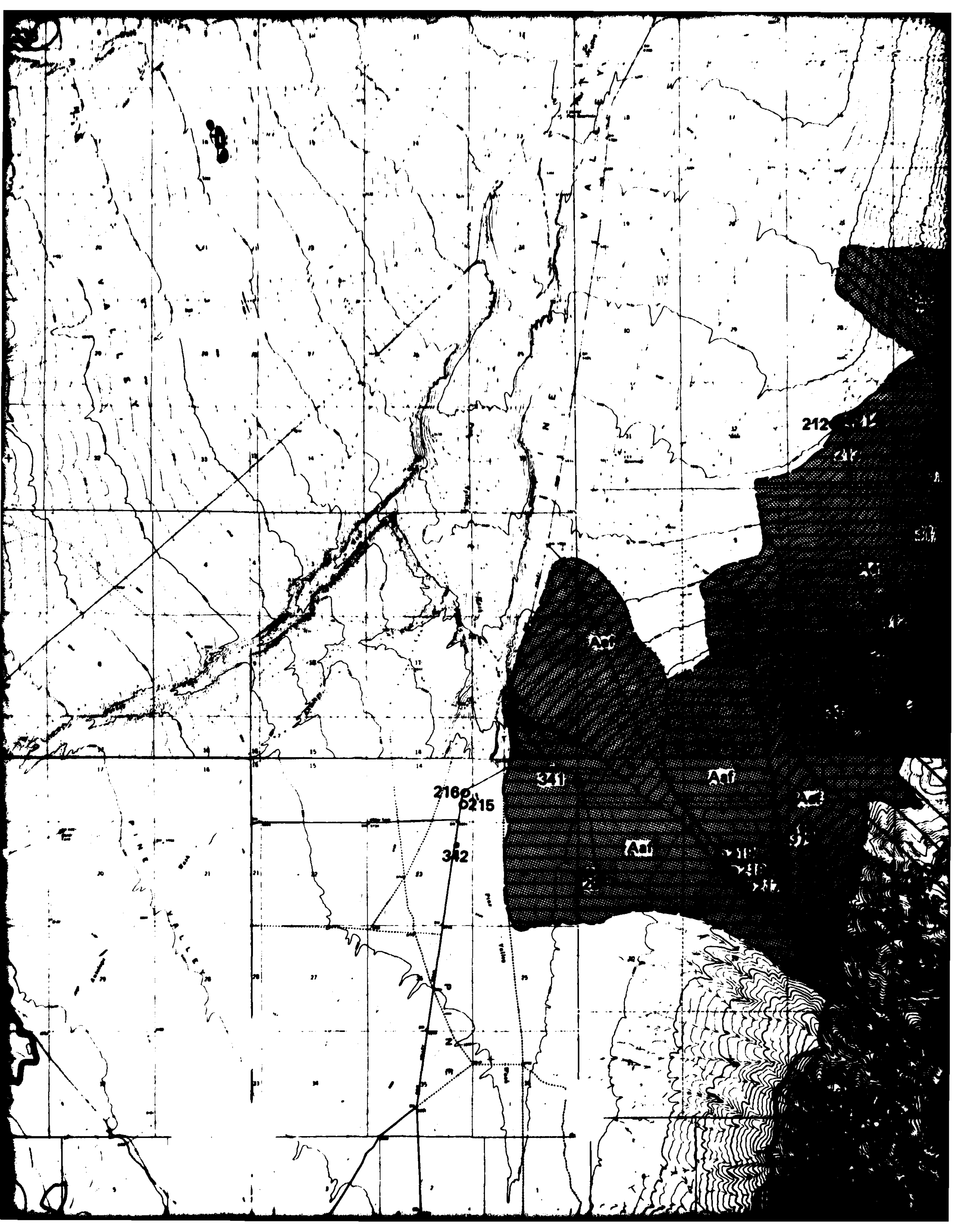
DESERT EXPERIMENTAL RANGE
DESERT
RANGE
EXPERIMENTAL
STATION
Pine Pass
Aaf
Aaf
330
247
Aol


JEEP TRAIL
Sand Pass
JEEP
Cave


ANTELOPE VALLEY

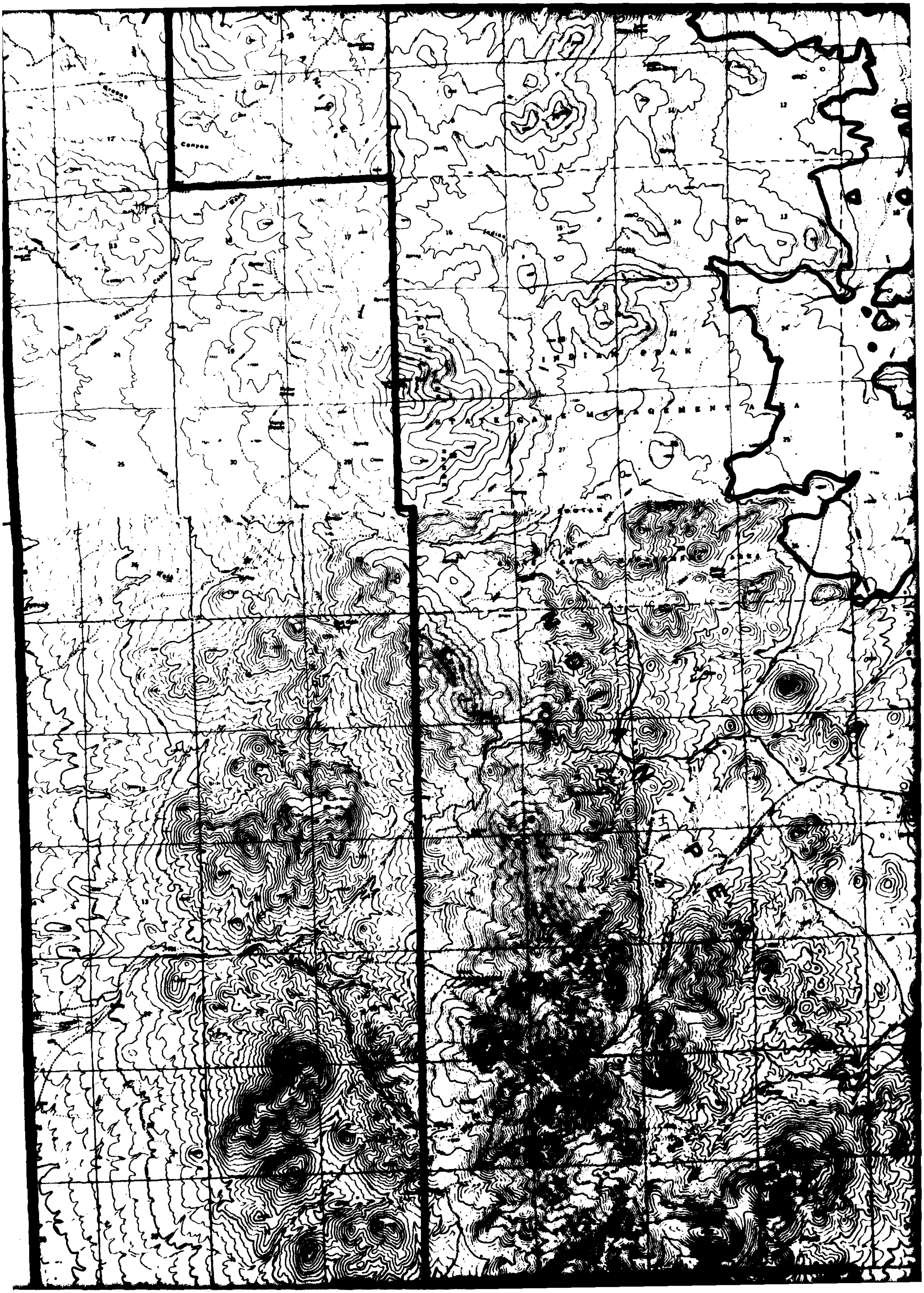

PINE VALLEY HARDPAN
DESERT
PINE VALLEY
RANGE
MILLARD CO
BEAVER CO
Range Headquarters
Experimental Plot
Desert Ranch Reservoir
Electric Fence Reservoir
Cow Camp Well
BM 5207
BM 5214
Gravel Pit
Cow Track Reservoir
BM 5232
BM 5170
BM 5105
FENCE
Aaf
332
323
324
322


339
340



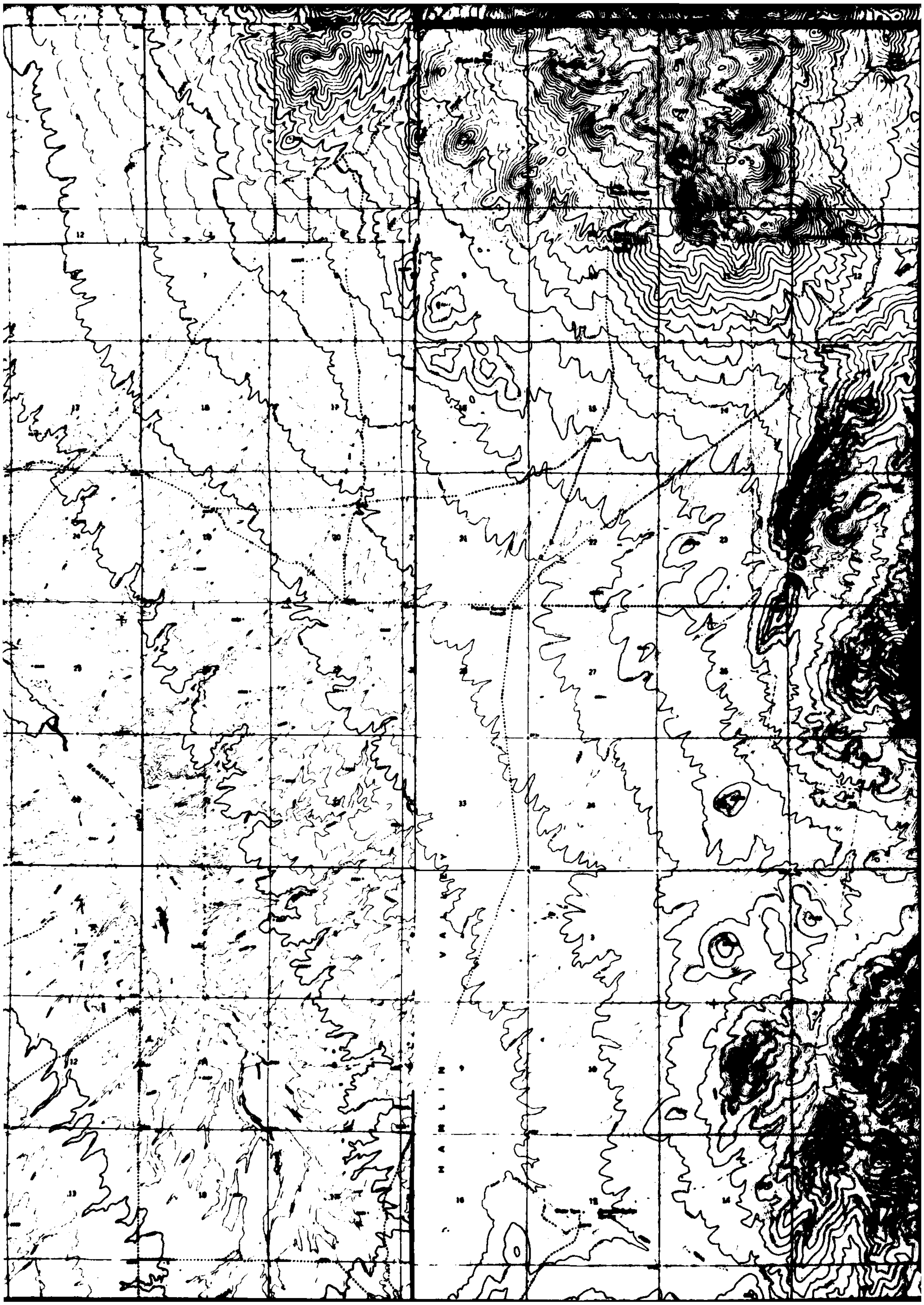
212
Aaf
341
Aaf
Aaf
Aaf
216
215
342

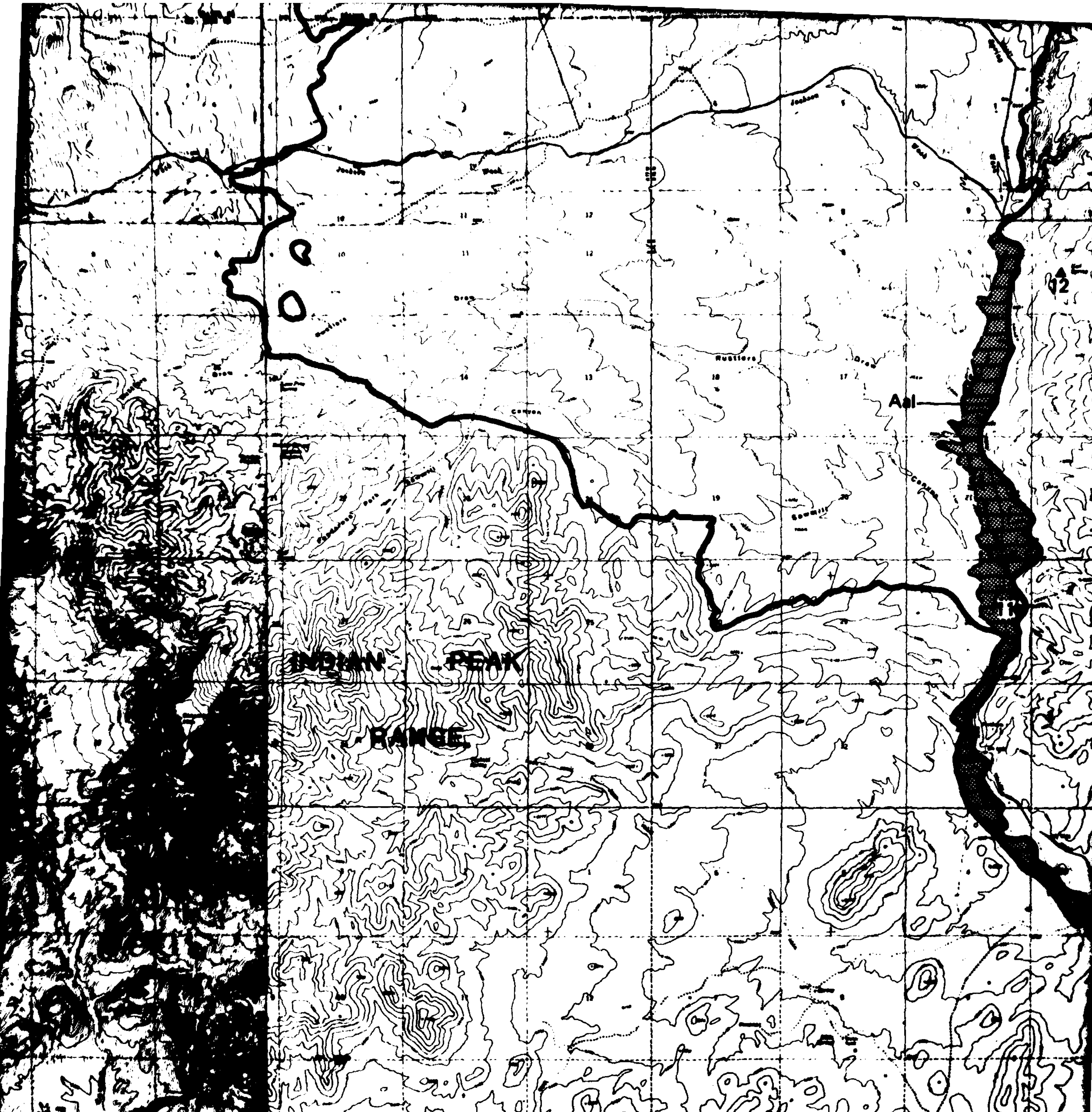
308
303
Qtz



INDIAN PEAK
STATE GAME MANAGEMENT AREA

30
18
222
221
220
A1
15C




INDIAN PEAK
RANGE
Aal
Rustlers
Draw
Canyon
Sawmill
Jackson
Wash

13

C WESTERN AGGREGATE RESOURCES STUDY FIELD STATIONS

VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY*
(MAP NUMBERS FROM 1 TO 199)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

DETAILED AGGREGATE RESOURCES STUDY**
(MAP NUMBERS FROM 200 TO 299 FOR BASIN–FILL AND ROCK SAMPLE LOCATIONS; 300 TO 399 FOR FIELD PETROGRAPHIC STATIONS)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

PETROGRAPHIC FIELD STATIONS

• DATA STOP

AGGREGA

BASIN–FILL AND ROCK SOURCES

CA1		BASIN FILL
		ROCK
CA2		BASIN FILL
		ROCK
CB		BASIN FILL
		ROCK
CC1		BASIN FILL
		ROCK
CC2		BASIN FILL

* SEE PINE VALLEY, WAH WAH VALLEY VSARS REPORT (FN-TR-37-g) FOR DETAILED INFORMATION.

** SEE CORRESPONDING MAP NUMBER IN APPENDICES A AND B FOR DETAILED INFORMATION.

*** A COMPLETE CLASSIFICA[T] BASIN–FILL OR ROCK SOU[RCE] THE STUDY AREA.

16

14

EXPLANATION

ASSIFICATION SYSTEM

IN–FILL OR ROCK SOURCES CONTAINING
REGATES THAT PRODUCED TRIAL MIX
CRETE WITH 28 - DAY COMPRESSIVE
ENGTHS EQUAL TO OR GREATER THAN
) PSI.

IN–FILL OR ROCK SOURCES CONTAINING
REGATES THAT PRODUCED TRIAL MIX
CRETE WITH 28 - DAY COMPRESSIVE
IENGTHS LESS THAN 6500 PSI.

SIN–FILL OR ROCK SOURCES CONTAINING
GREGATES POTENTIALLY SUITABLE FOR USE
CONCRETE; BASED ON ACCEPTABLE LABORA-
RY AGGREGATE TEST RESULTS.

SIN–FILL OR ROCK SOURCES CONTAINING
GREGATES POTENTIALLY SUITABLE FOR USE
CONCRETE; BASED ON CORRELATION WITH
ASS CA1 OR CA2 SOURCE AREAS.

SIN–FILL SOURCES CONTAINING AGGREGATES
TENTIALLY SUITABLE FOR USE IN CONCRETE;
SED ON CORRELATION WITH CLASS CB SOURCE
IEAS.

SIN–FILL SOURCES CONTAINING FINE AGGREGATES
ED WITH CRUSHED-ROCK SAMPLES FOR CERTAIN
NCRETE TRIAL MIXES.

ISUITABLE SOURCES OF BASIN–FILL MATERIALS
IAT MAY LOCALLY CONTAIN POTENTIALLY SUITABLE
URCES OF AGGREGATES OF LIMITED EXTENT.
ITESTED SOURCES OF ROCK MATERIALS THAT MAY
NTAIN POTENTIALLY SUITABLE CRUSHED-ROCK
GREGATES (SEE TEXT FOR ADDITIONAL INFORMA-
ON).

YSTEM IS SHOWN, ALTHOUGH ALL
MAY NOT BE PRESENT WITHIN

GEOLOGIC UNITS†

BASIN–FILL UNITS

Aal	STREAM-CHANNEL AND
Aaf	ALLUVIAL FAN DEPOSI
Aol	OLDER LACUSTRINE DE

ROCK UNITS

Qtz	QUARTZITE
Ls	LIMESTONE
Cau	CARBONATE ROCKS UN

† SEE APPENDIX TABLE F-3 FOR SYMBOL EX

SYMBOLS††

STUDY AREA BOUND

ROCK/BASIN–FILL CO

GEOLOGIC ROCK CON

BASIN–FILL CONTAC

†† GEOLOGIC ROCK AND BASIN–FILL CON
APPROXIMATELY LOCATED AND MAY V

1

UNITS

ANNEL AND/OR TERRACE DEPOSITS (A1/A2)

FAN DEPOSITS (A5)

CUSTRINE DEPOSITS (A4o)

TS

E (M4 AND/OR S1)

NE (S2)

TE ROCKS UNDIFFERENTIATED (S2)

R SYMBOL EXPLANATION AND COMPARISON.

AREA BOUNDARY

ASIN–FILL CONTACT

GIC ROCK CONTACT

FILL CONTACT

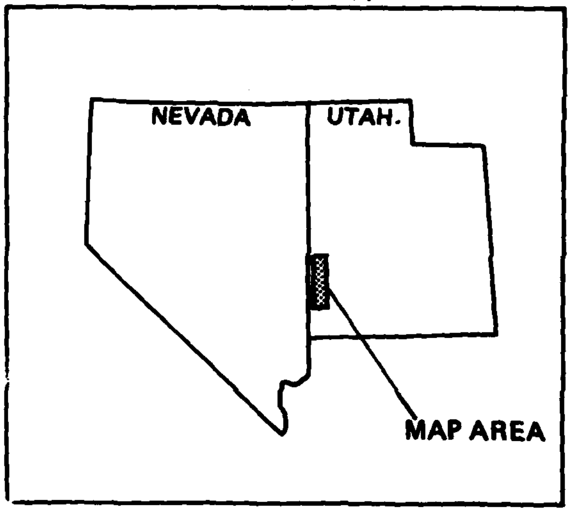
IN–FILL CONTACTS ARE
D AND MAY VARY LOCALLY.

SCALE 1:62,500

0 1 2
STATUTE MILES

0 1 2
KILOMETERS

LOCATION MAP



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CONCRETE AGGREGATE RESOURCES MAP
DETAILED AGGREGATE RESOURCES STUDY
PINE VALLEY, UTAH

12 JUN 81

DRAWING 3

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